BEST AVAILABLE IMAGES

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images may include (but are not limited to):

- BLACK BORDERS
- TEXT CUT OFF AT TOP, BOTTOM OR SIDES
- FADED TEXT
- ILLEGIBLE TEXT
- SKEWED/SLANTED IMAGES
- COLORED PHOTOS
- BLACK OR VERY BLACK AND WHITE DARK PHOTOS
- GRAY SCALE DOCUMENTS

IMAGES ARE BEST AVAILABLE COPY.

As rescanning documents *will not* correct images, please do not report the images to the Image Problem Mailbox.

PCT WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 : C21D 9/00, F27D 5/00

A1

(11) International Publication Number: **WO 99/07903**

(43) International Publication Date: 18 February 1999 (18.02.99)

(21) International Application Number: PCT/GB98/02325

(22) International Filing Date: 12 August 1998 (12.08.98)

(30) Priority Data:
9717032.8 12 August 1997 (12.08.97) GB

(71) Applicant *(for all designated States except US)*: KVAERNER METALS CONTINUOUS CASTING LIMITED [GB/GB]; Prince of Wales Road, Sheffield S9 4EX (GB).

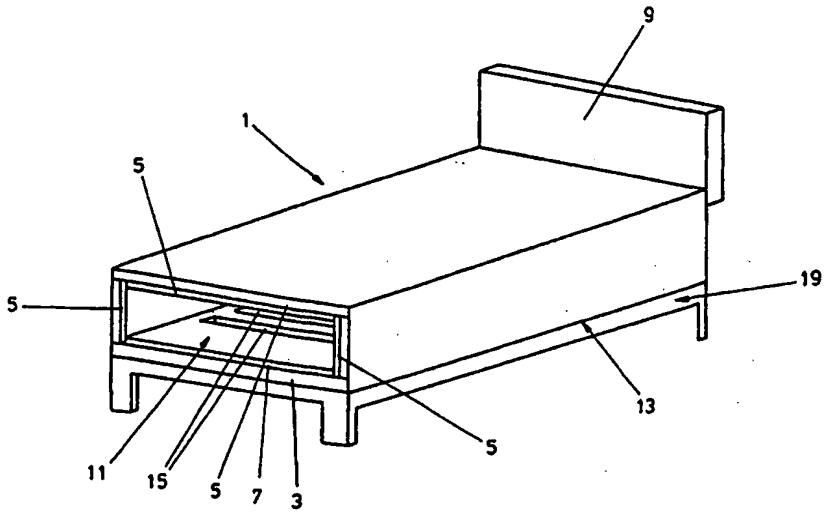
(72) Inventor; and
(75) Inventor/Applicant *(for US only)*: REYNOLDS, Timothy [GB/GB]; 1 St. Helen's Croft, Grindleford, Hope Valley S32 2JG (GB).

(74) Agent: PAWLYN, Anthony, Neil; Urquhart-Dykes & Lord, Tower House, Merrion Way, Leeds LS2 8PA (GB).

(81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE, GH, GM, HR, HU, ID, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published
With international search report.
Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.

(54) Title: IMPROVEMENTS IN AND RELATING TO HANDLING MATERIALS



(57) Abstract

The invention provides a transportable unit and a method of transporting such units for conveying hot products, such as cast products between locations. The method comprises introducing the product to a transport unit (1) at a first location, supporting the product by a thermal insulating material provided by the transport unit (1), moving the transport unit away from the first location and to a second location, the product and thermal insulating material remaining in substantially the same position relative to one another during movement and removing the product from the transport unit (1) at the second location. In this way heat losses from the product are minimised as heat losses to the immediate environment through conductive and radiant loss to the transporting apparatus is minimised. The system also introduces considerable flexibility in the conveying of products between a separate locations in process plant. This facilitates changes and replacement of apparatus without major interruption to the process routes production capacity.

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AL	Albania	**ES**	Spain	**LS**	Lesotho	**SI**	Slovenia
AM	Armenia	**FI**	Finland	**LT**	Lithuania	**SK**	Slovakia
AT	Austria	**FR**	France	**LU**	Luxembourg	**SN**	Senegal
AU	Australia	**GA**	Gabon	**LV**	Latvia	**SZ**	Swaziland
AZ	Azerbaijan	**GB**	United Kingdom	**MC**	Monaco	**TD**	Chad
BA	Bosnia and Herzegovina	**GE**	Georgia	**MD**	Republic of Moldova	**TG**	Togo
BB	Barbados	**GH**	Ghana	**MG**	Madagascar	**TJ**	Tajikistan
BE	Belgium	**GN**	Guinea	**MK**	The former Yugoslav Republic of Macedonia	**TM**	Turkmenistan
BF	Burkina Faso	**GR**	Greece			**TR**	Turkey
BG	Bulgaria	**HU**	Hungary	**ML**	Mali	**TT**	Trinidad and Tobago
BJ	Benin	**IE**	Ireland	**MN**	Mongolia	**UA**	Ukraine
BR	Brazil	**IL**	Israel	**MR**	Mauritania	**UG**	Uganda
BY	Belarus	**IS**	Iceland	**MW**	Malawi	**US**	United States of America
CA	Canada	**IT**	Italy	**MX**	Mexico	**UZ**	Uzbekistan
CF	Central African Republic	**JP**	Japan	**NE**	Niger	**VN**	Viet Nam
CG	Congo	**KE**	Kenya	**NL**	Netherlands	**YU**	Yugoslavia
CH	Switzerland	**KG**	Kyrgyzstan	**NO**	Norway	**ZW**	Zimbabwe
CI	Côte d'Ivoire	**KP**	Democratic People's Republic of Korea	**NZ**	New Zealand		
CM	Cameroon			**PL**	Poland		
CN	China	**KR**	Republic of Korea	**PT**	Portugal		
CU	Cuba	**KZ**	Kazakstan	**RO**	Romania		
CZ	Czech Republic	**LC**	Saint Lucia	**RU**	Russian Federation		
DE	Germany	**LI**	Liechtenstein	**SD**	Sudan		
DK	Denmark	**LK**	Sri Lanka	**SE**	Sweden		
EE	Estonia	**LR**	Liberia	**SG**	Singapore		

IMPROVEMENTS IN AND RELATING TO HANDLING MATERIALS

This invention concerns improvements in and relating to handling materials, and particularly, but not exclusively, to the means and methods of transporting and handling hot semi finished products, such as cast products, between stages of processing.

Hot products and in particular products from casting machines need to be transported between a variety of subsequent operation stages, such as rolling. Particularly with long thin sections, transportation by lifting handling methods is difficult or inappropriate as the materials sag significantly, additionally they lose heat quickly due to the slow means of transport and large surface areas. As a consequence conventional transportation systems use mainly roller table transfer systems or other same level transport. These are linear in arrangement to ensure full support for the products.

Roller table transfer systems employ a series of rollers over which the material is conveyed, the rollers rotating as the material passes. Significant problems also occur with such systems, however, due to the large temperature difference between the material being conveyed, its environment and the conveying system.

Heat losses from a high temperature product are based on a function of ΔT^4, where ΔT is the temperature difference between the product surface and the environment to which the heat is radiated. Roller tables are sometimes insulated in order to conserve heat in the product. The product however moves quickly along the roller table and even an insulated environment has little time to heat before the article has passed. The temperature differences and hence losses are therefore high. This problem applies to the rollers contacting the product too. No sooner has the product heated the roller than it has passed it. Additionally the loss to the conveying

means is not assisted by the need to cool this equipment to protect mechanical parts such as bearings and roller stiffness. This maintains temperature differences and hence losses in this part of the system too.

Any form of heat loss and the resulting cooling of the material is undesirable as this impairs good rolling performance and diminishes product quality in terms of properties and geometric tolerances. These problems are exacerbated where cooling is non-uniform, for instance where only part of the material contacts rollers or transport devices such as cross transfer skids.

According to a first aspect of the present invention we provide a transport unit for a hot product, such as a cast product, the unit comprising structural support means and a layer of thermally insulating material.

The cast product may be a long product, such as bloom, beam blank, billet, or flat product such as slab or strip. The transport unit is particularly suited to thin slabs, strips and other relatively thin products. The product may be transported in a substantially planar configuration or in a coiled configuration.

The cast product thickness may have a maximum value of less than 400mm, less than 150mm, less than 90mm or even less than 50mm.

The cast product may have a width of at least 55mm. The cast product may have a width of at greatest 3.5m, or 5m, or 7m or 10m.

The length of the cast product may be at least 5m or at least 10m or at least 17m or at least 28m or even greater than 50m.

The transport unit is particularly suited to conveying cast products whose length to thickness ratio means that they are insufficiently self supporting to be lifted. Preferably the length to thickness ratio is greater than 250:1, preferably greater than 375:1, or greater than 400:1, more preferably greater than 2500:1 and potentially even greater than 6250:1.

It is particularly preferred that the length to thickness ratio for cast products of thickness 90mm to 200mm is greater than 150:1 and more preferably greater than 250:1. It is particularly preferred for cast products whose thickness is between 60mm and 30mm for the length to thickness ratio to be greater than 375:1 and more preferably greater than 400:1. Preferably cast products having a thickness of less than 30mm have a length to thickness ratio of greater than 1000:1 and more preferably greater than 2000:1.

The cast product may comprise a slab of substantially 10m in length and 250mm in thickness, and/or 17m in length and 150mm in thickness and/or, 28m in length and 90mm in thickness, and/or 50m in length and 50mm in thickness.

The casting may have a temperature of at least 200°C, more preferably at least 400°C and even at least 800°C during transportation and/or at introduction to and/or at removal from the transport unit.

The structural support means may comprise a framework. The framework may form the corners and edges of the unit. Cross bracing elements may be provided. A rectilinear support framework may be provided. The framework may define a substantially rectilinear box. The framework may define a substantially cylindrical box or polygonal box or hexagonal cross-sectioned box. The support means may substantially enclose the exterior of the box. The framework may be of steel. The framework may be provided with lifting or handling

points, for instance to engage with a crane, or other lifting apparatus or motion providing apparatus.

The unit may be provided with a top, bottom and two side walls. The side walls may be opposing side walls. The unit may define a free space between the walls. The unit may be in the form of a sleeve which is open at both ends but which has two side walls, a top and a bottom wall. Alternatively one or both ends of the unit may be provided with walls.

One or more of the walls may be removable from the other walls to allow access to the free space defined between them. Access may be obtained through one or both of the open ends of the unit.

In one embodiment, the unit may be provided with first and second opposing walls and one or more side walls connecting the opposing walls. A single connecting wall may be provided in the case of a cylindrical unit, with 6 side walls being provided in a hexagonal cross-sectioned unit, or other numbers in the case of other polygonal sided boxes. One or both of the opposing walls may be removable to allow access to the free space defined between them. The thermal lining of the unit may, at least in part conform to the exterior of the product. For instance, the lining may be provided with a curved portion, particularly at the bottom, to cooperate with the product.

The unit may include a base structure onto which the hot product carrying part of the unit can be provided. The hot product carrying part may be lowered on to the base structure and/or the base structure may be lifted up under the hot product carrying part and/or the two parts may be slid into position relative to one another.

In one embodiment, in addition to a sleeve, open at one or both ends, the unit may include a base structure on which the sleeve can be mounted.

The base structure may be provided with means, such as upstanding elements, which close the open end(s) of the hot product carrying part.

The base structure may close off the aperture(s) in the base of the hot product carrying part when the hot product carrying part is provided on the base structure. The base structure may be provided with element(s) which correspond to the profile of the aperture(s) so as to close them.

The top wall may be detachable, with or without one or more side walls, to expose the cast product on the bottom wall.

The top wall may extend over the ends of the side wall(s) or be substantially accommodated within the boundaries of the side wall(s).

The bottom wall may extend under the ends of the side wall(s). The side wall(s) may rest on the bottom wall in the closed position. Alternatively, the bottom wall may be substantially accommodated within the boundaries of the side wall(s). The side wall(s) may form part of the bottom wall in the closed position.

One or both of the end walls may be removable and/or provided with a door. The doors or ends may swing open and/or slide open. In this way access to the free space within may be provided.

The thermally insulating material is preferably separate from the support means, although the thermally insulating material may contribute to the structural support and/or form the support means.

Preferably the thermally insulating material forms a bottom surface for the inside of the unit. The thermally insulating material may provide the bottom of the unit or provide a lining

to the bottom of the unit. Structural support may be provided for the bottom of the unit. The support may be provided under, within and/or by the bottom thermally insulating layer.

Preferably a thermally insulating material forms a top surface for the inside of the unit. Preferably a thermally insulating material forms one or more of the side surfaces of the inside of the unit.

The thermally insulating material may provide the top and/or side(s) of the unit alone or provide a lining to the top and/or side(s) of the unit. Structural support may be provided for the top and/or side(s) of the unit. The support may be provided outside and/or under the insulating layer.

A thermally insulating material may form an end, ends, door or doors of the unit. The thermally insulating material may provide an end, ends, door or doors of the unit alone or by providing a lining to the end, ends, door or doors of the unit. Structural support may be provide for one or more of the ends or doors. The support may be provided outside and/or within the insulating layer.

The thermally insulating material for the bottom of the unit has preferably refractory properties, most preferably to withstand product surface temperature of at least 1300°C. A thermally insulating material capable of supporting at least 20 kN/m^2 and more preferably at least 60 kN/m^2 may be provided. Preferably support of at least 60 kN/m^2 is provided for thicker slab or materials up to 300mm thick and for example at least 20 kN/m^2 for slabs or materials up to 100mm thick is preferred for the bottom of the unit. Preferably the walls and/or top of the unit are provided with a thermally insulating material with low heat capacity but able to also withstand product surface temperatures at least 1300°C.

The bottom of the unit may be provided with one and preferably more apertures. Preferably the apertures extend from the inside of the unit through the insulating lining and/or structural frame. Preferably the apertures can be releasably sealed with closure members, most preferably of complimentary profile to the apertures. The closure members preferably comprise thermally insulating material. The closure members may consist of thermally insulating material or be provided with a layer of thermally insulating material, ideally towards the innermost portion thereof.

Preferably in the sealed state the inner surface of the closure members is recessed relative to and more preferably approximately flush with, the inner surface of the insulating material forming the bottom of the unit.

Preferably in the open state the apertures are adapted to receive rollers for transferring the cast product into or out of the transport unit. The rollers may be provided on the transport unit, for instance as part of the base. The rollers may be provided on a moveable component for the transport unit, for instance on top of the moveable component and under the transport unit. The rollers may be provided at the loading and/or unloading location, for instance discrete from the transport unit or moveable component. In such a case the transport unit may be introduced above the rollers at those locations to facilitate introduction of the rollers into the transport unit.

Alternatively the open apertures may correspond with alternative same level transfer systems such as skid or walking beam cross transfer devices.

When used in conjunction with roller transfer means before and after residence in the transport unit, the apertures may extend across a portion, or substantially the full width, of the free space of the unit. One or more apertures may be provided in a

given width extent. Preferably the apertures extend for the substantial portion of the length of the unit, that is along the direction of travel of the casting into, and/or out of, the unit. Preferably the apertures are perpendicular to the direction of travel by which the casting is moved into, and/or out of, the free space. Where alternative transport means are employed before or after residence in the transport unit such as skid cross transfer means then the apertures will be arranged to specifically suit the arrangement of this transport means.

The means for transporting the transport unit may be provided in one or more of a variety of ways. The provision of the transport unit as a detached unit from the transport means is particularly advantageous. This detachable nature allows a variety of different transport means to be employed, enabling same and different level transport in a flexible manner, whilst also allowing the plant infrastructure to cope with a large variety of transport units designed for different products.

The transport unit may be transported independently, by crane or other handling means e.g. conveyor, between corresponding statically located transfer means such as roller tables or other same level transfer means. Alternatively the transport unit may be mounted on a moveable component, such as a cart, trolley conveyor or form of vehicle. Rollers or other transfer devices may be adopted to enter the unit and may be provided on the moveable component or on a separate but corresponding moveable component or components.

The moveable component may also incorporate the aperture closure numbers such that the apertures are sealed once the rollers or other transfer devices are disengaged from the transport unit.

According to a second aspect of the invention we provide a method of transporting a hot product, such as a cast product

between locations, the method comprising introducing the product to a transport unit at a first location, supporting the product by a thermal insulating material provided by the transport unit, moving the transport unit away from the first location and to a second location, the product and thermal insulating material remaining in substantially the same position relative to one another during movement and removing the product from the transport unit at the second location.

The first location is preferably associated with a casting unit. The first location may be a set of rollers receiving cast products from the casting unit. The casting unit is preferably a thin slab caster or other casting unit producing long, thin, hot product. The first location may follow a heating stage in the production line.

The second location is preferably a finishing line for hot, typically cast products. The second location may be a rolling stage. The second location may be a set of rollers for feeding hot products to a finishing line. The second location may be a heating stage, for instance prior to the rolling stage.

Preferably the product is introduced and/or removed from the transport unit using carrying means. Most preferably the carrying means contact the product during introduction and/or removal of the product, the carrying means being out of contact with the product during the movement of the transport unit and/or during storage of the product in the transport unit.

The carrying means may be one or more rollers, lifting means, conveyor belt or the like.

The cast product may be introduced to the unit from the first location by means of rollers. The cast product may be removed from the unit to the second location by means of rollers. The rollers of the first and/or second location may be aligned with

rollers provided to be positioned within the unit during loading and/or unloading.

The method may include the introduction of rollers into the unit during loading and/or unloading. The rollers may be removed and/or introduced through apertures in the base of the unit. The rollers may support the cast product during its loading into the unit. The rollers may then be lowered relative to the unit and/or the unit elevated relative to the rollers to transfer the cast product to a support surface provided in the unit. The rollers may be elevated relative to the unit and/or the unit lowered to transfer the casting from the support surface to the rollers during unloading. Most preferably the rollers are not in contact with the product during transportation and/or storage. Most preferably the rollers only contact the product during loading and/or unloading of the product. The rollers may move into and/or out of the apertures along linear or along non-linear, for instance arc like, paths. Alternatively, the unit may correspond with an alternative same level transfer system such as a cross transfer device.

The product may be lifted into the transport unit, particularly in the case of a coiled or wound product. The product may be lifted by a mandrel, and preferably a mandrel introduced into the central aperture of the product. Once inserted into the transport unit the product may be lowered onto the insulating lining. Preferably the lifting means, such as the mandrel, is removed during transportation. Preferably the transport unit is closed, for instance by providing a wall for the access aperture, during transportation and/or storage. The product may be removed from the transport unit using means of an equivalent type.

Preferably the support surface is a layer of thermal insulation.

An end or door on the unit may be opened to load and/or unload the casting. Preferably the end or door is closed during loaded transportation. The unit may be opened and/or closed by moving the hot product carrying part of the unit relative to a base structure part of the unit. The hot product carrying part of the unit may be open at both ends.

The cast product may be supported directly by the thermally insulating material. Alternatively or additionally the cast product may be supported by components or a layer of material insulated relative to the external environment of the unit by a layer or components of a thermally insulating material.

The unit may be transported from the first to second location by movement of the unit over rotatable means, such as further rollers and/or by moveable lifting means and/or by a moveable carrier for the unit. The detached nature of the transport unit relative to its mode of transport is particularly advantageous. The rotatable means may be provided in a linear or non-linear path. The lifting means may comprise an overhead crane or vehicular crane or other form of vehicular lifting device. The moveable carrier may comprise a cart, trolley, shuttle, vehicle or the like.

The cast product may be a long product, such as bloom, beam blank, billet, or flat product such as slab or strip. The transport unit is particularly suited to thin slabs, strips and other relatively thin products. The products may be conveyed flat or in rolled or coiled form.

The cast product thickness may have a maximum value of less than 400mm, less than 150mm, less than 90mm or even less than 50mm.

The cast product may have a width of at least 55mm. The cast product may have a width of at greatest 5 or 10m.

The length of the cast product may be at least 5m or at least 10m or at least 17m or at least 28m or even up to at least 50m.

The transport unit is particularly suited to conveying cast products whose length to thickness ratio means that they are insufficiently self supporting to be lifted. Preferably the length to thickness ratio is greater than 250:1, preferably greater than 375:1 or greater than 400:1, more preferably greater than 2500:1 and potentially even greater than 6250:1.

It is particularly preferred that the length to thickness ratio for cast products of thickness 90mm to 200mm is greater than 150:1 and more preferably greater than 250:1. It is particularly preferred for cast products whose thickness is between 60mm and 30mm for the length to thickness ratio to be greater than 375:1 and more preferably greater than 400:1. Preferably cast products having a thickness of less than 30mm have a length to thickness ratio of greater than 1000:1 and more preferably greater than 2000:1.

The cast product may comprise a slab of substantially 10m in length and 250mm in thickness, and/or 17m in length and 150mm in thickness and/or, 28m in length and 90mm in thickness, and/or 50m in length and 50mm in thickness.

The casting may have a temperature of at least 200°C, more preferably at least 400°C and even at least 800°C during transportation and/or at introduction to and/or removal from the transport unit.

One or more separate cast products may be accommodated in a single unit. A plurality of billets, blooms or blanks could be accommodated, for instance.

The cast product may be heated during transportation. Transportation may include movement of the unit and/or storage pending unloading. The top wall and/or side walls may be

detached and/or removed from the bottom wall to allow access to the cast product for heating. The heating means may be placed over the cast product and/or bottom wall. Or the transport unit, whole or part, may be positioned under the heating unit for instance.

During transportation and/or storage of a cast product in a transport unit an oxygen excluding gas or atmosphere may be provided within the transport unit.

The unit may be transported with its direction of movement substantially along its long axis and/or with its direction of travel substantially perpendicular to its long axis or in a combination thereof.

During transport the orientation of the cast product may be reversed head to tail.

A single unit may be provided for transporting cast products between the first and second location. Preferably two or more units are provided. Preferably a plurality of units transporting cast products to the second location and/or a plurality of empty units returning towards the first location are provided. Preferably at least 1 and more preferably at least 6 units are provided for each casting unit in the production line.

The units may follow a non-linear path between first and second locations and/or between second and first locations. The non-linear path may be curved or include one or more curved sections. The non-linear path may include one or more changes of movement direction. The non-linear path may include one or more path portions at an angle, for instance 90°, to the preceding path portion. The casting location and rolling location may not be aligned with one another.

One or more loaded transport units may be provided between the first and second location, whilst another unit is loaded and/or unloaded. Preferably at least two loaded units are always provided. One or more unloaded transport units may be provided between the second and first locations whilst another is loaded and/or unloaded. Preferably at least two unloaded units are always provided.

Two or more first, for instance casting, locations may be provided for each second, for instance rolling, location. Units from the two first locations may alternately pass to the second location. The two first locations may be linked to the second by a linear path for one and a non-linear path for the other, or a non-linear path for both. The non-linear path(s) may be curved or include curved portions and/or include one or more changes of movement direction, for instance 90° change(s).

The first and second locations may be relatively adjacent or relatively distant.

The method may include any of the options, features and possibilities set out elsewhere in this document.

According to a third aspect of the invention we provide a method of adapting an existing processing line comprising a rolling unit to connect a new casting unit to the rolling unit, wherein a new casting unit is provided and linked to the roller location by a transportation method according to the second aspect of the invention and/or using a transport unit according to the first aspect of the invention.

The existing rolling unit may be fed from an existing thick slab caster. The new casting unit may be a thin slab caster.

The new casting unit may be built whilst production is continued via the existing casting unit. The new casting unit may be operably connected to the roller unit whilst production

is continued via the existing casting unit. The transportation system may be provided without major changes to configuration of the position of the existing plant.

The plant may be arranged such that production may use thick or thin slabs as feedstock.

The adaption may further provide the demolition or removal of the existing casting unit and/or other apparatus once the new casting unit is operational. A further new casting unit may be provided, for instance to replace the removed existing casting unit. Preferably the second new casting unit is connected to the existing roller location using the method of the second aspect of the invention and/or the unit of the first aspect of the invention.

The first and/or second new casting unit may be connected to the roller location via a non-linear path. The first and/or second line may be provided wit a buffering capacity between the casting unit production and the rolling unit production by incorporating hot slab storage preferably utilising multiple transport units.

Heating may be applied before, after or during transportation, or a combination of two or more of these.

The adapted production line may include any of these features, options or possibilities set out elsewhere in this document.

According to a fourth aspect of the present invention we provide a cast product or a finished cast product transported in a unit according to the first aspect of the invention and/or according to the method of the second aspect of the invention and/or arising from a plant adapted according to the third aspect of the invention.

According to a fifth aspect of the invention we provide apparatus for transporting units carrying casting products and/or empty units for carrying casting products, the apparatus comprising at least one unit receiving location and the apparatus being rotatably mounted.

The units may be provided as detailed in the first aspect of this invention.

The unit receiving location(s) may extend radially from the mounting or a hub provided thereon. The unit receiving locations may comprise slots, for instance configured to the external profile of the units or a portion thereof. The apparatus preferably provides 2 or more and preferably 8 or more receiving locations. The receiving locations may be evenly positioned around the apparatus.

The apparatus may receive a loaded unit(s) from a first path and rotate prior to providing the loaded unit(s) to a second path. The first path may come from a casting location. The second path may lead to a rolling location. The first path may be separated from the second path by a rotation of the apparatus of between 30° and 330°, for instance 90°, 180° or 270°.

The apparatus may alternatively or additionally receive empty unit(s) from a path and rotate prior to providing the empty unit(s) to a further path. The path may lead from a rolling location and/or the further path may lead to a casting location. The path and further path may one or both be the same as the second and first paths respectively. The first and/or second paths may be provided with passing locations for units.

A separate such apparatus may be provided on the path and further path to the apparatus provided on the first and second path.

One or more other units may be dispatched and/or received between the receipt and dispatch of a given unit by the apparatus.

An alternative to the revolving drum is a vertical Paternoster conveyor system which will allow storage with the minimum of floor area.

Embodiments of the invention will now be described, by way of example only, and with reference to the accompanying drawings in which :-

Figure 1 shows a transport unit according to the invention;

Figure 2a shows the transport unit of Figure 1 being loaded;

Figure 2b shows the transport unit of Figure 1 loaded;

Figure 3 shows a product carrying part of a transport unit according to a further embodiment of the invention;

Figure 4 shows the base part of the transport unit of Figure 3;

Figure 5 shows a combined product carrying part and base part of a transport unit according to a further embodiment of the invention;

Figure 6 shows an embodiment of the transport system in operation;

Figure 7 shows an alternative embodiment of the transportation system;

Figure 8 shows a further embodiment of the transportation system;

Figure 9a shows a still further embodiment offering a buffer capacity;

Figure 9b shows an alternative embodiment offering a buffer capacity;

Figure 10a shows a further embodiment for dual casting machines and a single rolling unit;

Figure 10b shows an alternative embodiment offering dual casting units and a single rolling unit;

Figure 10c shows an extension of the Figure 7b system to provide buffering capacity;

Figure 11a illustrates a first stage in the adaption of an existing casting plant;

Figure 11b illustrates a second stage in the adaption of an existing casting plant;

Figure 12 illustrates a revolving transportation/buffering system;

Figure 13a to 13d show a number of embodiments of transport units embodying the invention;

Figures 14a and 14b respectively show a loading state and transport state for a further embodiment of the invention;

Figures 15a and 15b respectively show a loading state and transport state for a further embodiment of the invention; and

Figures 16a, 16b, 16c and 16d show a further embodiment of the invention relating to the loading and transport of product according to a still further embodiment of the invention.

A large variety of metal shapes, sizes and cross-sections are produced by casting of molten metal. Sections leaving a casting unit then pass to further units for further processing towards the desired form. Such units include rollers intended to produce the desired dimension of product. These subsequent processes are performed on the still hot metal, with temperatures elevated significantly above the environment by the heat retained from the casting process and further added heat.

The consequent process units are separate from the casting unit and as a consequence necessitate the transportation of the section from one location to another. The dimensions of many sections mean that they cannot be transported by lifting as they sag to too great a degree. Beds of rollers are thus used to support the section during transportation.

During transportation the exposure of the section to the environment and its contact with the rollers leads to cooling. This cooling can give rise to impaired performance of the subsequent processes and a diminished product quality as a result.

The transport unit illustrated in Figure 1 consists of an insulated sleeve into which the section is placed soon after casting. The unit 1 comprises a support frame 3 to give the unit structural rigidity during transportation. The frame 3 is lined with an insulating material 5 around both sides and across the top surface. An insulated liner 7 is also provided across the base of the unit 1 to support the section. The insulated liner 7 may be different to the liner 5 to obtain sufficient support for the section weight.

Slideably mounted doors 9 are provided at each end of the unit 1 to provide access to the interior 11. The base 13 of the unit 1 is provided with a series of apertures 15 in the

structural frame 3 and insulating liner 7. These apertures are normally obscured by insulated plugs 17.

The unit 1 is supported on a cart 19 and can be lifted and lowered relative to the cart by hydraulics.

To receive a section 21, Figure 2a, the cart 19 and unit 1 is brought into proximity with a bed of rollers 23 which extend from a casting machine, not shown. The aperture plugs 17 are then removed and the unit 1 is lowered on the cart 19 until a set of rollers 25, also mounted on the cart 19, extend through the apertures 15 into the interior of the unit 1. The rollers 25 form a continuous transfer surface with the rollers 23 extending from the casting machine. The door 9 is opened at this time. The unit 1 is now ready to receive a section 21 and this is carried into the interior of the unit by rollers 25.

Once the section is fully located within the unit 1 the unit 1 is lifted once more to retract the rollers 25 from the apertures 15. The weight of the section is thus transferred to the liner 7 at the bottom of the unit 1. The door 9 shuts on lifting and the insulating plugs 17 are inserted once more to completely enclose the section 21.

In this position the section 21 is fully insulated from the external environment and heat losses are thus reduced. The insulated liners 5,7 result in far less heat loss both due to their insulating properties and due to the fact that the section 21 is in contact with the same locations or have no movement relative to the product for a while so allowing them to heat and thus reduce the temperature difference ΔT. This compares with the prior art transport systems where the section would continuously be contacted with new parts of its environment as it moved. No relative movement between the section and its insulation occurs in the present invention.

The heat losses can be reduced still further by actively heating the insulating liners 5,7 prior to introduction of the section 21 to reduce ΔT and/or following introduction again to reduce ΔT. Active heating can also be used to achieve reheating of the section whilst it dwells in the unit 1 or to achieve temperature equalisation, partially or completely. Sections can therefore be retained in such units or a significant period of time without loss of heat and without loss significant of subsequent properties.

The unit 1 by providing support for the section 21 over a large area allows longer and/or wider sections to be successfully transported than is possible with the prior art.

The integral nature of the support for the section, which in effect follows any movement to which it is subjected, also allows the system to convey sections successfully in a variety of configurations. It is, therefore, possible to move the section vertically easily, to rotate it to travel broad ways, i.e through 90°, to rotate it round head to tail, i.e. through 180°, and also, by providing structurally supporting insulation on all sides, to rotate the section up onto its side and even over through 180° onto its other broad face.

Easier transversely arranged transportation is thus provided than can be achieved with prior art arrangements, for instance beam walking.

The embodiment of the invention describes the unit 1 as mounted on a cart 19. The unit can, however, be provided in other ways whilst obtaining the benefits of the invention. In particular the unit itself could be supported and moved by contact of it support frame 3 with a roller track. Reduced heat loss is still achieved, however, as movement between the insulation 5,7 and the section 21 is avoided. Similarly the unit 1 could be lifted onto the rollers 25 using a crane or other lifting means and additionally be conveyed from the casting to other desired

locations by such lifting means. Again the insulating benefits are retained.

The numerous ways in which the unit 1 can be conveyed around a plant provides a great deal of flexibility and versatility both to fit around existing plants in terms of the existing mode of transport, but also in terms of an increased capability to fit around the configuration of existing plant.

The discrete nature of the unit also allows it to quickly be removed from the production line should there be a problem with it or in the event of a plant stoppage; so minimising downtime.

In an alternative form, illustrated in Figure 3, the transport unit 30 is formed of a sleeve element 32 which, once loaded, is combined with a base element 34, Figure 4.

The sleeve element 32 is provide with an insulated liner 36 and the base of the sleeve 32 and liner 36 are provided with a series of apertures 38 which allow access for rollers 40 into the inside of the sleeve 32. The sleeve 32 is open at both ends 33a, 33b.

To load the sleeve 32, it is placed adjacent a roller bed 42. The roller bed 42 carries the slab 43 into the sleeve 32 and the rollers 40 support it therein. Once loaded inside the sleeve 32, the rollers 40 can be retracted and/or the sleeve 32 lifted, to remove the rollers 40 from the apertures 38 and leave the slab resting on the base of the sleeve 32.

When loaded the sleeve element 32 can be transferred to the base element 34 to complete the transport unit. The base element 34 is provided with end closures 35a, 35b, which are angled to correspond to and close off the ends 33a, 33b, of the sleeve element 32. The provision of end closures in this way simplifies the manner in which the unit is sealed and does away

with the need for moving parts and drive systems for them on the unit.

In the form illustrated in Figure 4, the base element 34 is provided with a series of insulated blocks 44 of corresponding profile to the apertures 38 in the sleeve 32. Once positioned on the base element 34 these blocks 44 completely seal the apertures 38 and render the slab fully isolated from its surroundings.

In the alternative assembled form of Figure 5, the base element 34 is provided without the blocks 44, the apertures 38 in the sleeve element 32 being insulted and sealed off by the more distant bottom 46 of the base element 34.

The mode of use of such a unit 1 in a casting plant is illustrated in Figure 6. Thin section are produced by casting molten metal supplied to a casting unit 50. The cast sections leaving the casting unit 50 supported by rollers 52 and pass through a heating unit 54. From this heating unit 54 the section passes to a set of rollers 56 docked with a unit 1. The section is thus fed into the unit 1 and the door and sealing plugs introduced.

In its closed, insulating state, the unit 1 is conveyed through the plant to the rolling stage 58. At the rolling stage 58 the unit 1 docks with a further set of rollers 60 and the section is removed from the unit 1 for rolling. The insulating capacity of the unit 1 and the flexibility of its mode of transport mean that the plant is not so restricted in terms of the distance between casting unit 50 and rolling stage 58, nor to any particular configuration of path there between.

Units of the same type can also be used to convey the section after the rolling stage 58 to other stages or locations if desired. For example heating may be provided for the section

after transfer from the casting unit 50 and prior to the rolling stage 58.

In the plant embodiment illustrated in Figure 7 the casting unit 50 and heating unit 54 feed sections to units 1 in the same way. However, this arrangement includes four separate units 1a, 1b, 1c, 1d. Thus whilst unit 1a is being loaded after the heating stage 54, unit 1b conveys and stores a section prior to rolling, unit 1c unloads a section to the rolling stage 58 and unit 1d is empty, returning to the loading dock. Such a system allows for non-linear routes between the casting and rolling stages and also provides a limited buffering capacity in terms of already loaded units ready for rolling and empty units ready for loading. Disruption in the casting and/or rolling stages can thus be more readily accommodated.

Figure 8 shows further the possibilities for non-linear transfer between the casting and rolling stage due to the greater and consistent structural support provided for the section in whatever configuration it is conveyed.

Figure 9a shows a further arrangement similar to that of Figure 6 but with a substantial buffer capacity. The system thus provides one unit 1a loading at the casting dock and one unit 1b which is unloading at the rolling dock. The system also shows full units 1c, 1d, 1e in transit to the rolling dock and empty unit 1f in transit back to the casting dock. This system provides a significant buffer should problems occur in a part of the plant. Thus rolling can be continued on the sections already loaded in the units should the casting be interrupted and casting can be continued by loading up the empty units should the rolling be interrupted. The system has a great ability to store the sections in a still useable condition within the units 1 during such delays.

An alternative buffering system, also facilitating non-linear transit is shown in Figure 9b. Again loading is provided for unit 1a, unloading for unit 1b, with full units 1c, 1d, 1e in transit and empty unit 1f in transit back towards the loading dock.

The non-linear transport capacity also allows, Figure 10a, the linking of more than one casting unit 75, 76 to a single rolling unit 77, or vice-versa. A similar facility can be provided by the alternative configuration of Figure 10b and this can be extended to include a significant buffer capacity using the system of Figure 10c.

In the majority of cases thin slab casting plant are built from new with a casting, heating and rolling stage provided in a new space with a free hand on layout. New plants are provided as the long slab lengths which must be handled in thin slab casting and the need for direct linking of the stages mean that adaption is not possible.

Difficulties with existing plant conversion arise from the casting units involved, as thick slab casters cannot easily produce thin slabs, and in terms of the transport links from casting to rolling, as the support provided or directness of the link may be far less. Thick slabs have far greater internal structural strength.

Conversion does, however, have attractions in terms of retaining the capital investment of the rolling stages and other parts of the finishing train as these are similar in both thick and thin slab processing. Even so conversion calls upon the demolition of the existing casting, heating and transport stages to provide the space in which the new thin casting, heating and transportation system is to be provided when prior art systems are used. This means that the plant is completely out of production for the period of the conversion at great cost. The present invention, however, allows conversion whilst

maintaining production from the existing plant right up to transfer over to production from the new plant. Minimal downtime therefore occurs.

Figure 11a illustrates the first stage of the conversion. The plant consists of an existing heating and casting unit 100 connected via roughing rollers 102 and then to finishing rollers 104. To convert the plant to a thin slab casting facility the existing line is retained in operation whilst a new casting 106, heating 108 and transportation system 110 is built. Due to the flexibility of the presently proposed transportation system the new line can be built at a location configured around the existing plant and the existing plant's operation can be maintained by providing the new unit transportation system 110 through the plant by the least interruptive route.

Once completed the thin slab casting facility can be brought on line and its products introduced to the existing rolling stage 104 using the units 1. If desired the thin and existing plant can then be run alongside one another using a single finishing train.

In the alternative that the existing plant is no longer needed then that plant can be demolished and removed.

If desired it is then possible to introduce another thin slab casting line making use of the space freed up by the demolition, Figure 11b. The two lines can then share the same finishing rollers 104 in the manner previously described, with a buffer capacity if desired.

Figure 12 illustrates apparatus which can be used to control the transfer of units 1 from one part of the transfer line between casting and rolling to another. The apparatus consists of a housing 200 provided with a series of recesses into which

units 1 can be received. The housing 200 is mounted so that it can revolve as desired.

In the shown position the empty unit in slot A is moved out of the housing 200 and onto a route leading back to the casting unit. At the same stage a full unit leaves slot E on a route towards the rolling stage. A full unit from the casting stage passes the returning empty unit, in a passing loop, and then progresses on to the housing 200. The full unit enters the housing 200 and occupies slot A. Similarly an empty unit returning from the rolling stage passes the full unit heading toward the rolling stage, the empty unit then slotting into slot E. The other slots B, C, D contain full units and slots F, G, H contain empty units. The housing 200 revolves one notch clockwise and the process is repeated; slot H feeds the empty unit to the casting stage, slot D the full unit to the rolling stage. The apparatus thus provides a storage area for the buffer units.

The above example presents the route to the rollers as being 180° from the route from the casting stage, but the two routes can be provided at any angular separation desired. The apparatus thus provides a ready manner for connecting sections of casting to rolling transport system to give a non-linear overall route. The route may of course include more than one such piece of apparatus.

As well as or as an alternative to loading or unloading the transport unit through its end, a variety of other possibilities exist, see Figures 13a to 13d.

In Figure 13a the transport unit comprises an insulated base 300 which supports the slab 302. The side walls 304 and roof 306 of the transport unit are detachable to provide access to the slab 302. The ends 308 of the walls 304 contribute to part of the base 300 in the closed position.

In Figure 13b a similar arrangement to that of Figure 13a is provided, but the ends 308 of the side walls 304 rest on the base 300.

Figure 13c illustrates a transport unit based around an inverted embodiment to that of Figure 13b. Here the side walls 304 are part of the base 300 with a detachable roof 306 which rests, in the closed position, on the side walls 304.

Finally, Figure 13d provides an inverted version of the Figure 13a embodiment with a detachable roof 306 accommodated within the profile of the side walls 304.

As well as allowing alternative access techniques these embodiments potentially enable process steps to be applied to the cast product in situ in the transport unit. For instance, the base 300 and slab 302 can be positioned to correspond with a heating unit to impart heat to the slab 302.

In the alternative embodiment of the invention illustrated in Figure 14a and 14b, the transport unit 500 is provided on a moveable component in the form of a carriage 502. The carriage 502 has wheels 504 which cooperate with rails 506 to control the direction of movement of the moveable carriage 502 and hence transport unit 500.

In the docking position, shown in Figure 14a, the transport unit 500 abuts the dock 508 and receives product 510 from there into the transport unit 500 through open door 512. The product 510 is supported in the dock 508 by rollers 514 and in the transport unit 500 by rollers 516 which protrude through openings 518 in the base of the transport unit 500, during loading.

Once loaded, the door 512 is closed. By providing an upward movement, arrows A, to the transport unit 500 relative to the carriage 502 the rollers 516 are retracted through the openings

518. This causes the product 510 to be lowered onto the insulating lining 522 of the transport unit 500, Figure 14b. The product 510 remains in this position during transport. There is no contact between the rollers 516 and the product 510 during transport. The openings 518 can be closed by insulating pieces as required. As illustrated in Figure 14b, a longitudinal movement is also applied to the transport unit 500, by pivoting about a series of axis.

To unload the product, on reaching another station (not shown), the transport unit 500 is lowered down so that the rollers 516 lift the product 510 and so facilitate product movement.

In a similar embodiment, illustrated in Figures 15a and 15b, the transport unit 500 and moveable carriage 502 are in fixed position. In this case, however, the rollers 516 are moveable from an inserted position, Figure 15a, where the product 510 is lifted and can be moved, to a retracted position, Figure 15b, where the product rests on the insulated lining 522. Closing elements 530 are provided to close the openings/apertures 518 following retraction of the rollers 516.

Whilst the embodiments illustrated above have shown the use of the system in relation to slab like products, the system is applicable to a variety of products which need to be conveyed, in an insulated state, between locations, including thinner coiled plate forms and wire.

In the embodiment of the invention illustrated in Figures 16a to 16d, a system for transporting coiled sheet product is illustrated.

In Figure 16a the hot sheet product 600 has been collected as a coil 602 and is moved from the collection location by lifting on a mandrel 604 inserted through the opening 606 in the centre of the coil 602.

The mandrel 604 is used to move the product 600 into an insulated transport unit 608 through an open side 610, Figure 16b. Once inside the mandrel 604 is lowered to rest the product 600 on the insulated lining 612 which forms the base of the unit 608. Further lowering of the mandrel 604 disengages the mandrel 604 from the product 600 and the mandrel 604 can hence be removed, Figure 16c.

Once loaded, the side 610 of the transport unit 608 can be closed using insulating element 614 and the unit 608 is ready for transportation, Figure 16d. At the end position the element 614 is removed to give access to the product 600 and it can be removed for further processing.

Whilst a circular cross-section transport unit 608 is preferred, due to the general correspondence with the product cross-section, other polygonal forms, such as hexagonal, can be used.

As an alternative to a mandrel, the product could be introduced by rolling the product into the transport unit and/or by conveying it on rollers. Apertures in the walls of the transport unit may be provided in such a case to facilitate introduction and removal of the product as described above.

In any or all of the embodiments it may be desirable to exclude oxygen from the transport unit, particularly where the slab or cast product will spend a significant period of time in the transport unit or is present at a high temperature. The oxygen is preferably excluded by providing an oxygen excluding gas or atmosphere, for instance, an inert gas. In this way scale formation can be suppressed.

CLAIMS:

1. A method of transporting a hot product, such as a cast product between locations, the method comprising introducing the product to a transport unit at a first location, supporting the product by a thermal insulating material provided by the transport unit, moving the transport unit away from the first location and to a second location, the product and thermal insulating material remaining in substantially the same position relative to one another during movement and removing the product from the transport unit at the second location.

2. A method according to claim 1 in which the cast product is introduced to the unit from the first location by means of carrying means, such as one or more rollers or lifting means .

3. A method according to claim 1 or claim 2 in which the carrying means are in contact with the product during loading and/or unloading and are removed from contact with the product during transportation.

4. A method according to claim 3 in which carrying means are rollers and the rollers are removed and/or introduced through apertures in the base of the unit.

5. A method according to any preceding claim in which the unit is transported from the first to second location by movement of the unit over rotatable means and/or by moveable lifting means and/or by a moveable carrier for the unit.

6. A method according to any preceding claim in which the cast product is heated during transportation.

7. A method according to any preceding claim in which during transportation and/or storage of a cast product in a transport

unit, an oxygen excluding gas or atmosphere is provided within the transport unit.

8. A method according to any preceding claim in which a plurality of units transporting cast products to the second location and/or a plurality of empty units returning towards the first location are provided.

9. A method according to any preceding claim in which one or more loaded transport units are provided between the first and second location, whilst another unit is loaded and/or unloaded.

10. A method according to any preceding claim in which two or more first locations are provided for each second location, the first locations being casting locations, the second location(s) being rolling locations.

11. A transport unit for a hot product, such as a cast product, the unit comprising structural support means and a layer of thermally insulating material.

12. A unit according to claim 11 in which the structural support means comprises a framework, the framework defines a substantially rectilinear box or a cylindrical box or polygonal box or a hexagonal box.

13. A unit according to claim 11 or claim 12 in which the unit is provided with a top, bottom and two side walls in the form of a sleeve which is open at both ends.

14. A unit according to any of claims 11 to 13 in which the bottom of the unit is provided with one or more apertures.

15. A unit according to claim 14 in which the apertures are releasably sealed with closure members.

16. A unit according to claim 15 in which in a sealed state the inner surface of the closure members is substantially flush with the inner surface of the insulating material forming the bottom of the unit.

17. A unit according to any of claims 14 to 16 in which in an open state the apertures are adapted to receive rollers for transferring the cast product into or out of the transport unit.

18. A unit according to any of claims 14 to 18 in which the means for transporting the transport unit are provided as a detached unit from the transport unit.

19. A unit according to any of claims 14 to 18 in which the unit includes a base structure onto which the part of the unit carrying the hot product is mounted.

20. A unit according to claim 19 in which the base structure is provided with upstanding elements which close the open end(s) of the hot product carrying part when the part of the unit carrying the hot product is mounted on the base structure.

21. A unit according to claim 19 or claim 20 in which the base structure closes off aperture(s) in the base of the hot product carrying part when the hot product carrying part is provided on the base structure.

22. A unit according to any of claims 14 to 18 in which the top wall is detachable to expose the cast product on the bottom wall.

23. A unit according to any of claim 14 to 22 in which one or both of the end walls are removable.

24. A unit according to any of claims 14 to 22 in which one or both ends usually are provided with a door.

25. A method of connecting a first metal processing unit to a second metal processing unit, wherein the first and second met6al processing units are linked by a transportaion method according to any of claims 1 to 10 and/or using a transport unit according to any of claims 11 to 24.

26. A method according to claim 25 wherein the first and metal processing units are selected from a casting unit, a rolling unit, a heating unit.

27. A method of adapting an existing processing line comprising a rolling unit, to connect a new casting unit to the rolling unit, wherein a new casting unit is provided and linked to the roller location by a transportation method according to any of claims 1 to 10 and / or using a transport unit according to any of claims 11 to 24.

28. A method according to claim 27 in which the existing rolling unit is fed from an existing thick slab caster and the new casting unit is a thin slab caster.

29. A method according to claim 27 or claim 28 in which the new casting unit is built whilst production is continued via the existing casting unit.

30. A method according to any of claims 27 to 29 in which the adaption further provides the demolition or removal of the existing casting unit, once the new casting unit is operational.

31. A method according to any of claims 27 to 30 in which a further new casting unit is provided and the second new casting unit is connected to the existing roller location using the

method of any of claims 1 to 10 and/or the unit of any of claims 11 to 24.

32. Apparatus for transporting units carrying casting products and/or empty units for carrying casting products, the apparatus comprising at least one unit receiving location and the apparatus being rotatably mounted.

33. Apparatus according to claim 32 in which the transport units are provided according to any of claims 11 to 24.

34. Apparatus according to claim 32 or 33 in which the unit receiving location(s) extends radially from the mounting or a hub provided thereon.

35. Apparatus according to any of claims 32 to 34 in which the apparatus receives a loaded unit(s) from a first path and rotates prior to providing the loaded unit(s) to a second path.

36. Apparatus according to claim 35 in which the first path comes from a casting location and the second path leads to a rolling location or heating locations.

37. Apparatus according to any of claims 32 to 36 in which the apparatus receives empty unit(s) from a path and rotates prior to providing the empty unit(s) to a further path.

38. Apparatus according to claim 37 in which the path leads from a rolling location or heating location and the further path leads to a casting location.

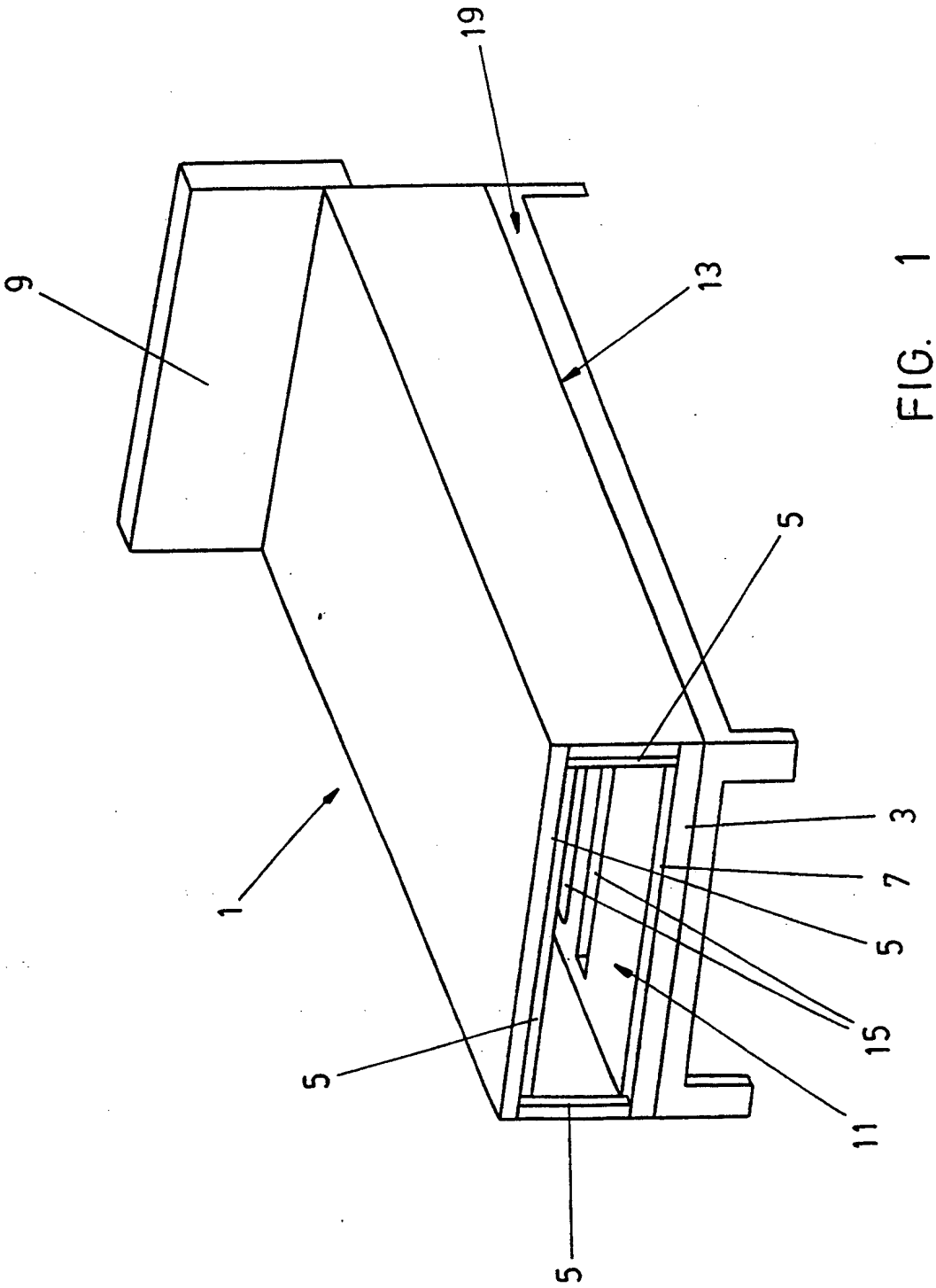


FIG. 1

FIG. 2a

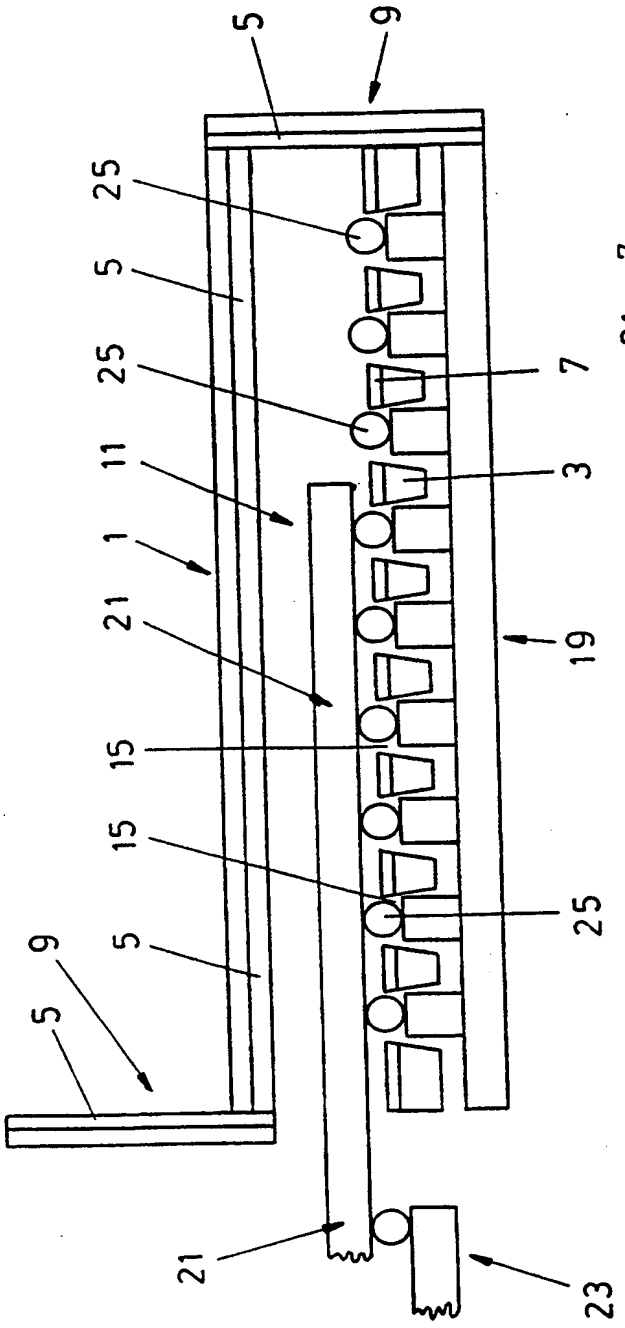


FIG. 2b

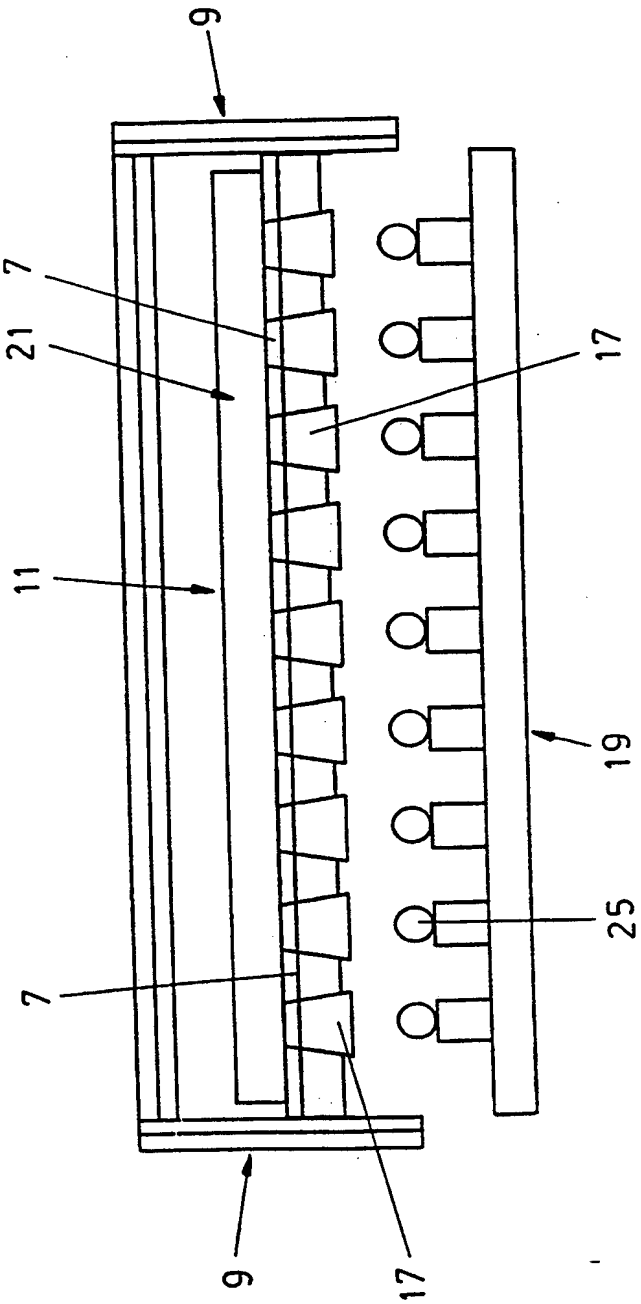


FIG. 3

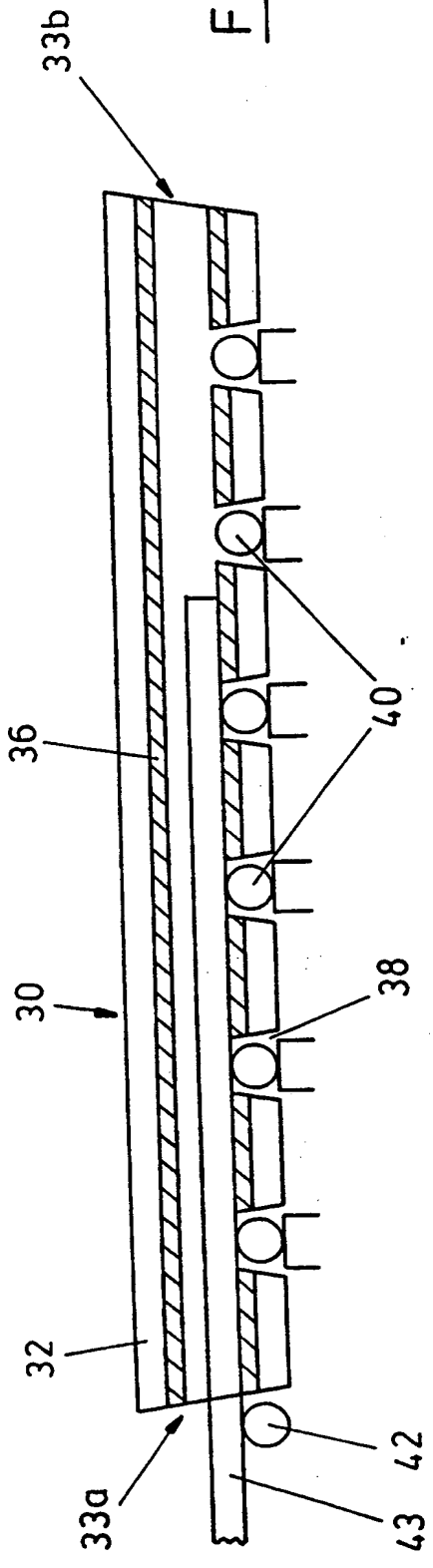


FIG. 4

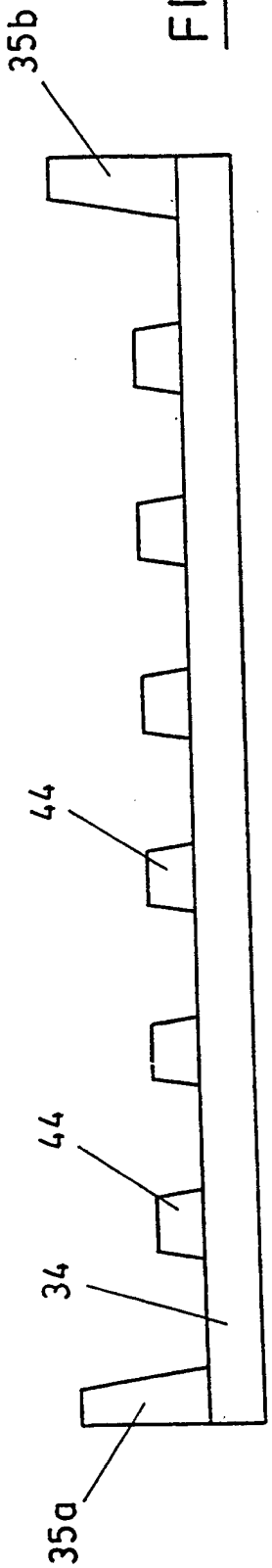
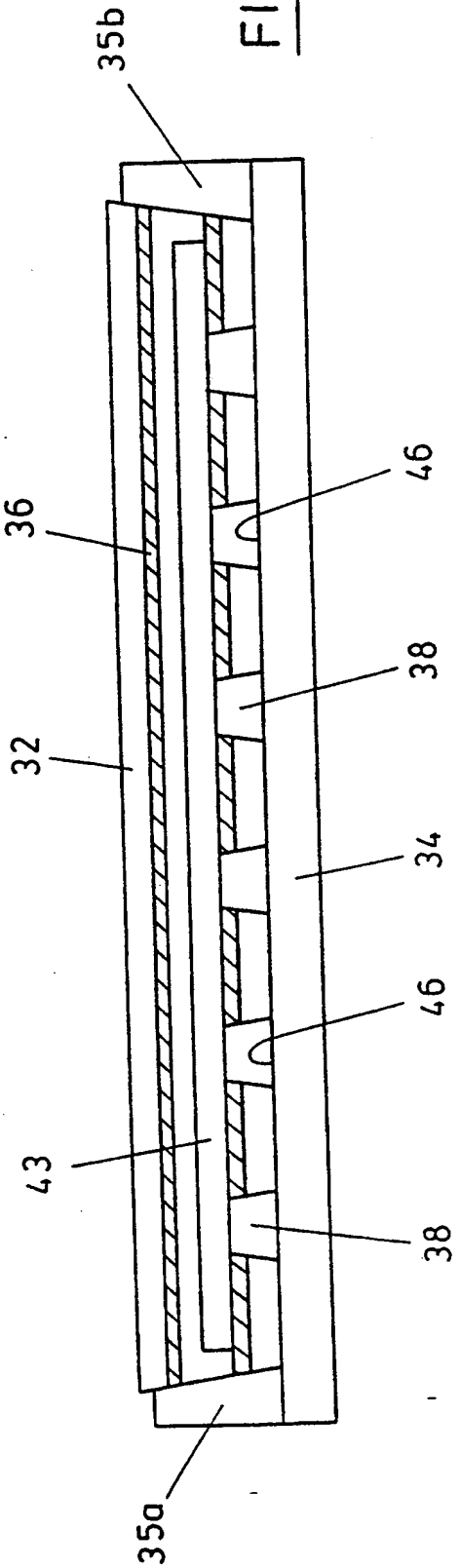


FIG. 5



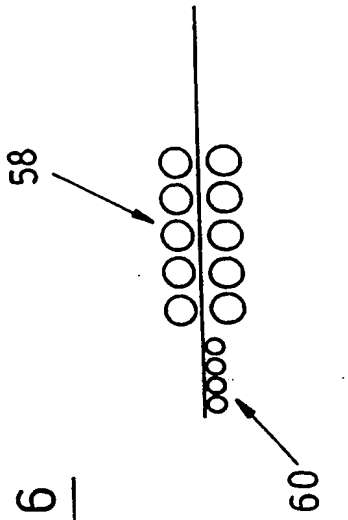


FIG. 6

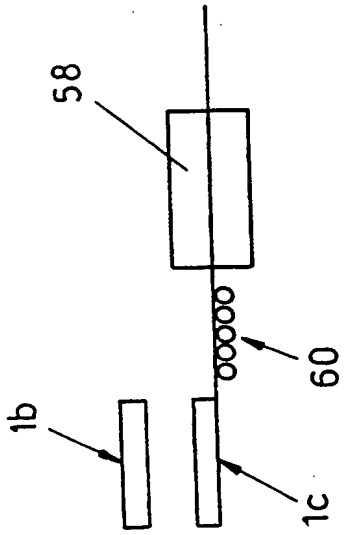


FIG. 7

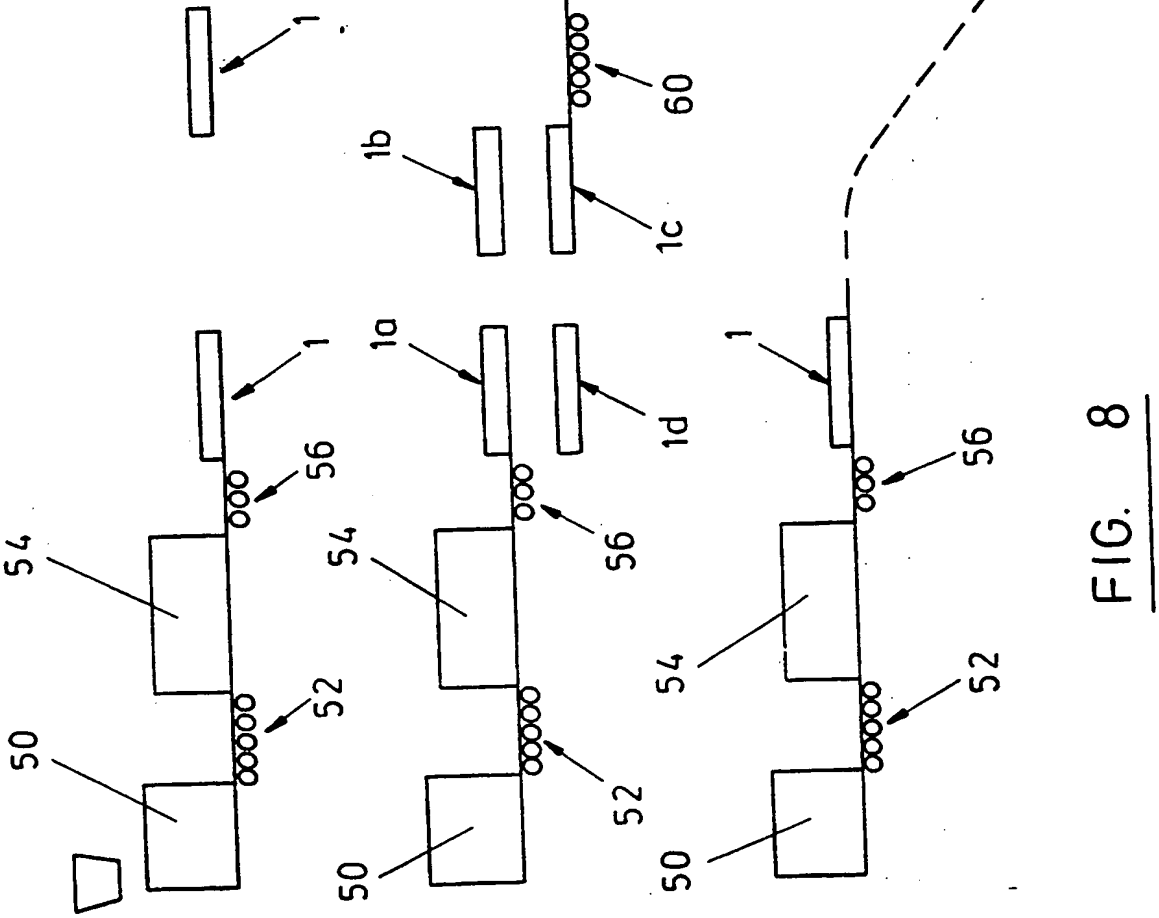


FIG. 8

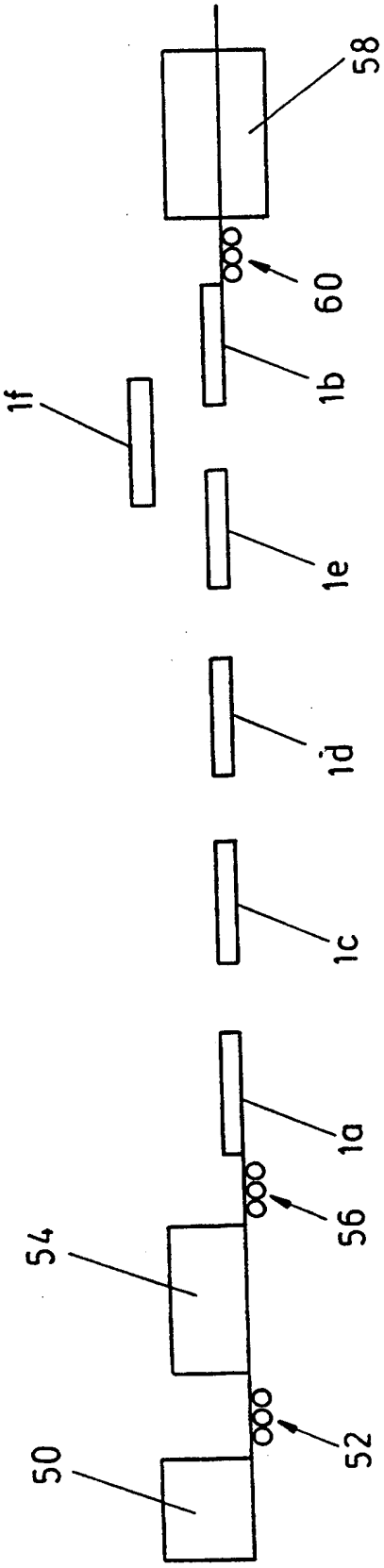


FIG. 9a

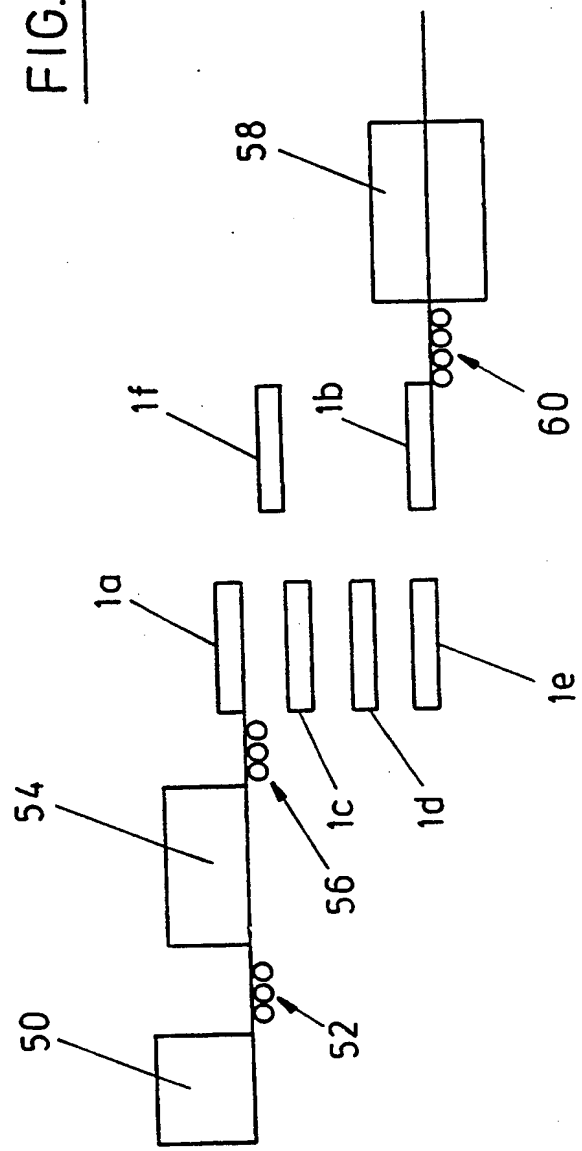


FIG. 9b

FIG. 10a

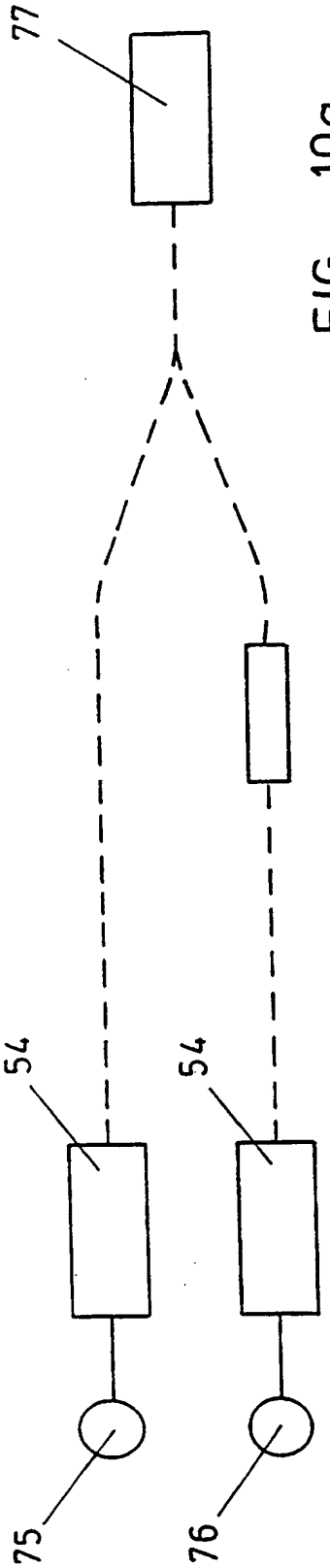


FIG. 10b

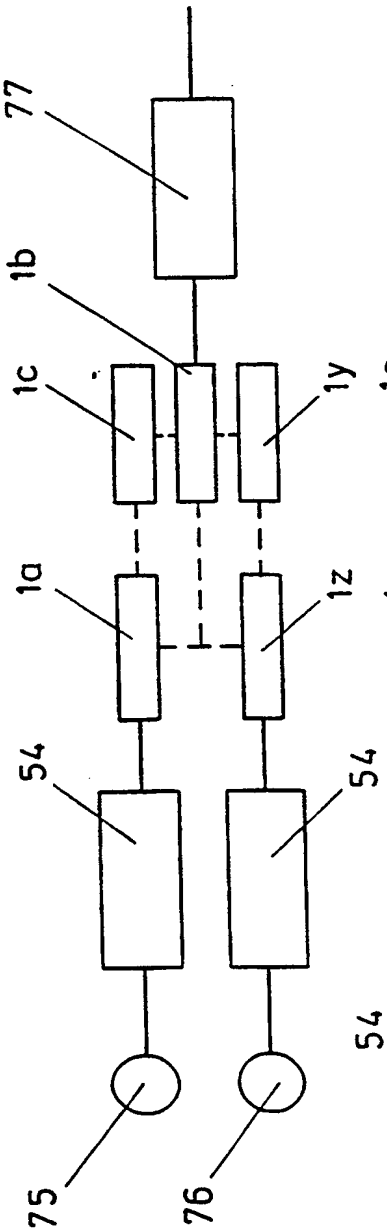
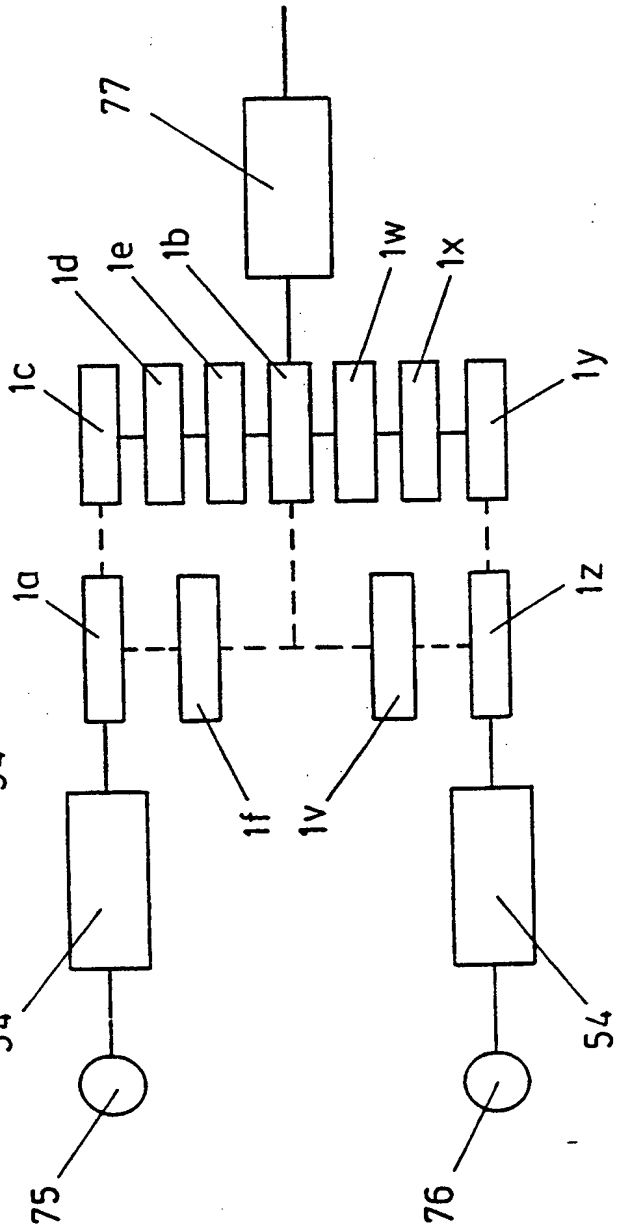


FIG. 10c



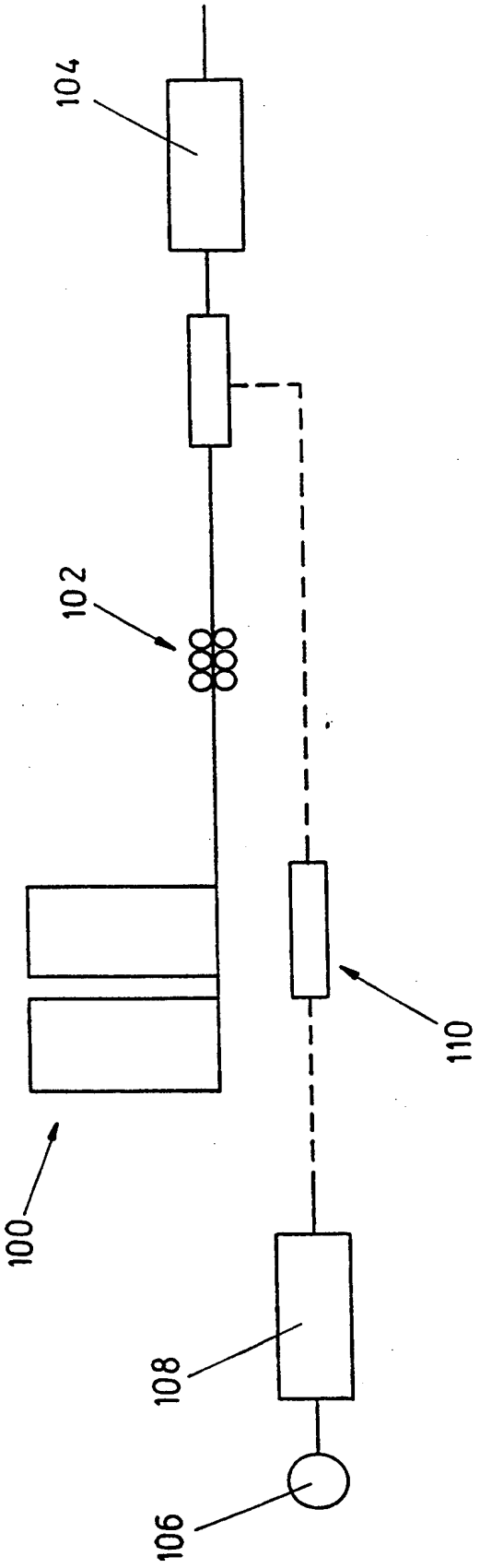


FIG. 11a

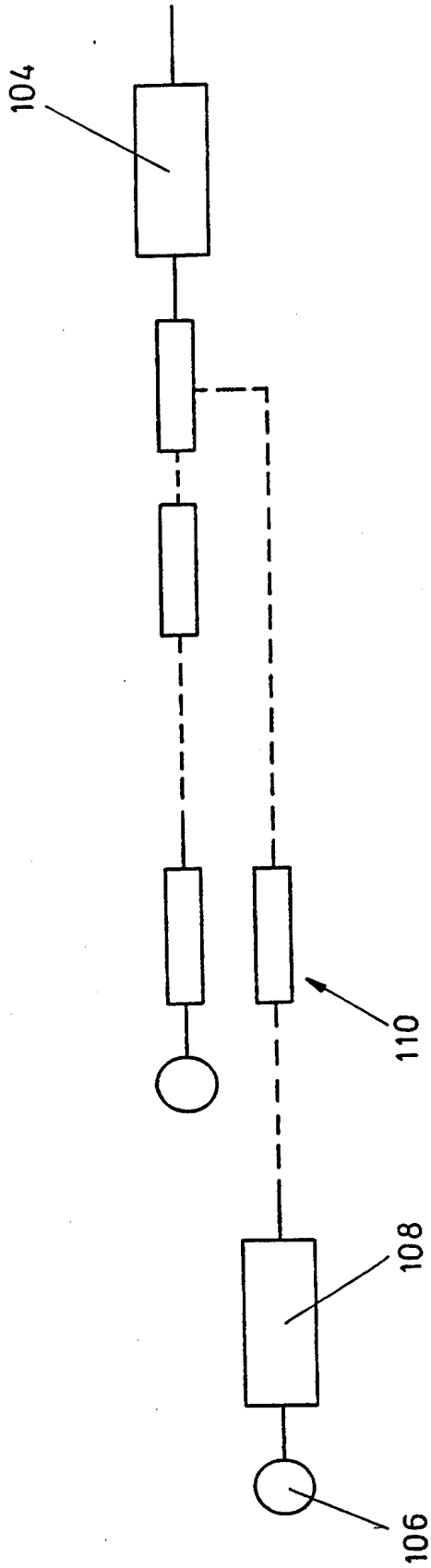
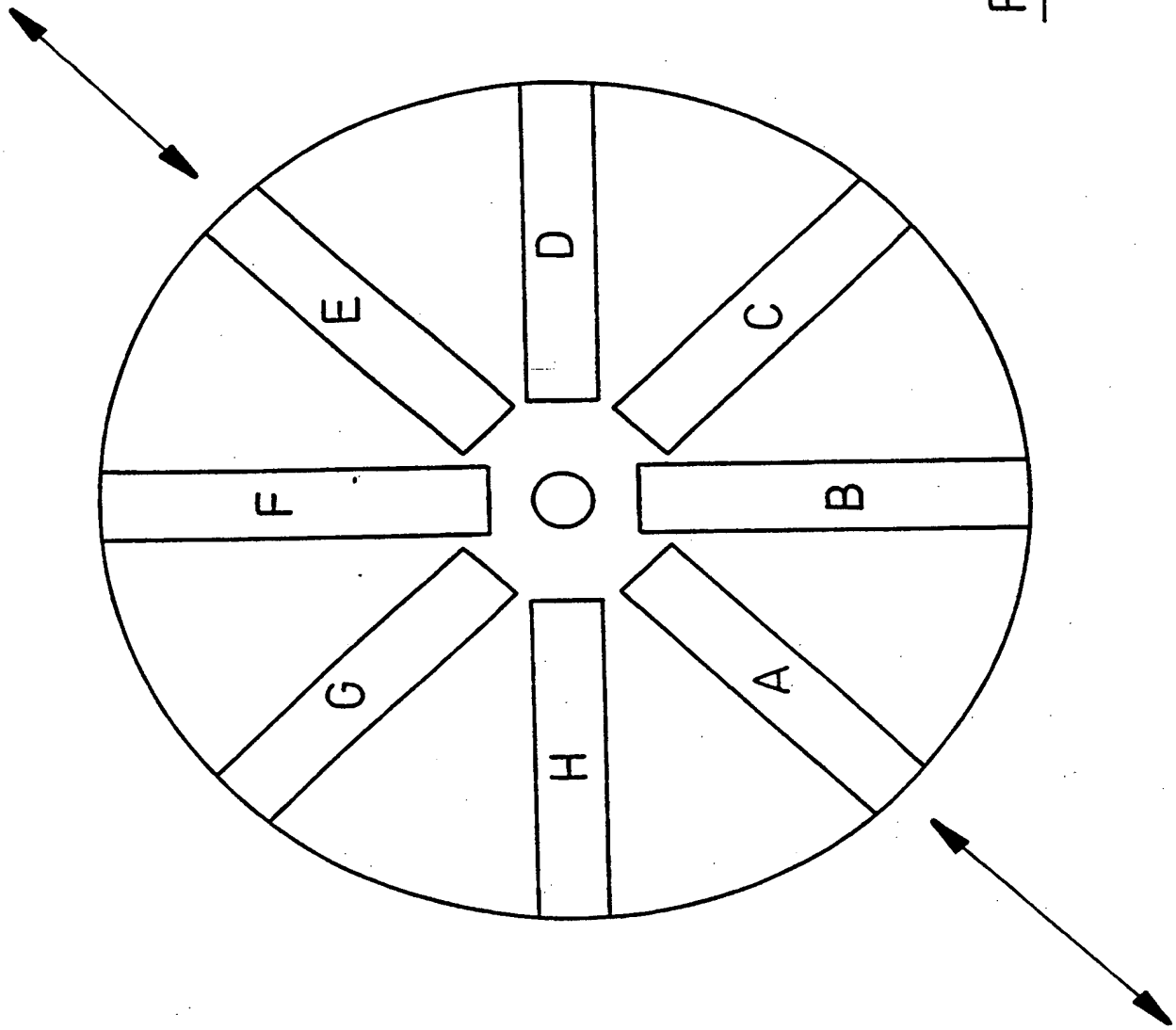


FIG. 11b

FIG. 12



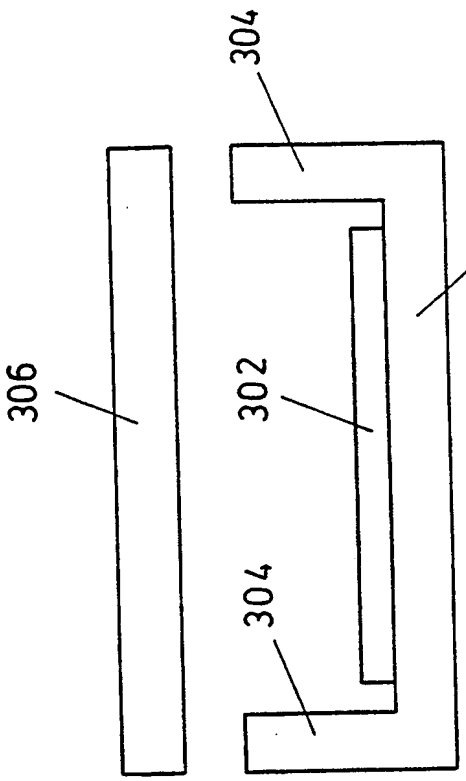


FIG. 13c

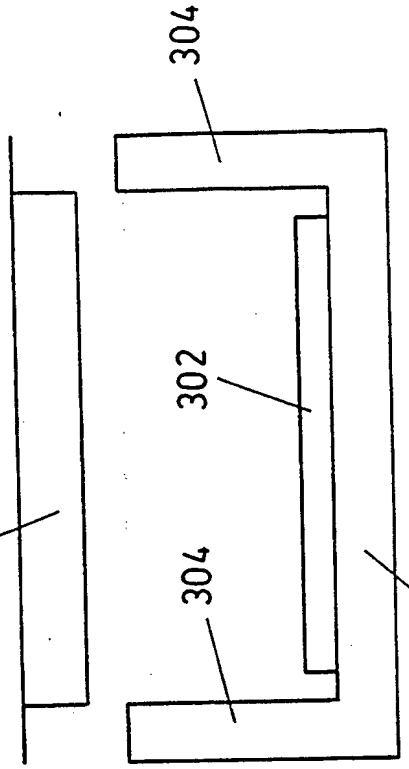


FIG. 13d

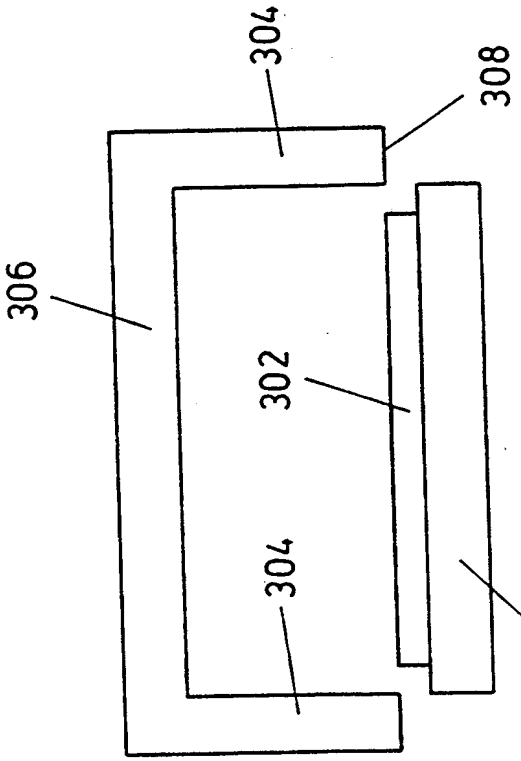


FIG. 13a

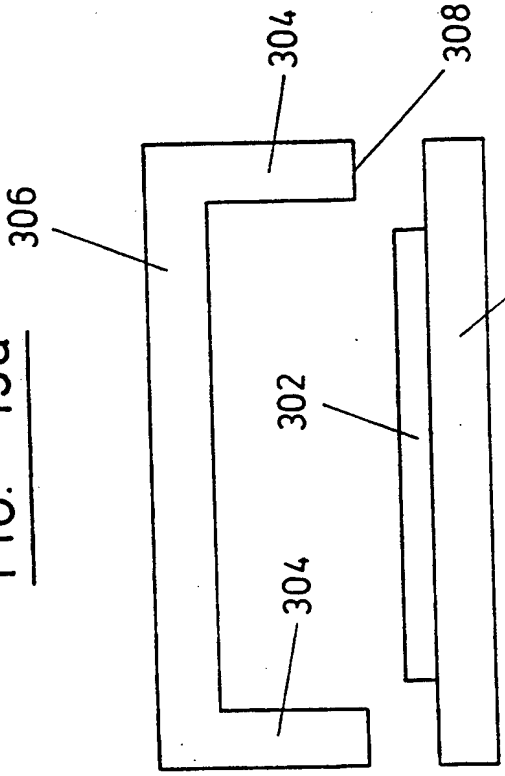


FIG. 13b

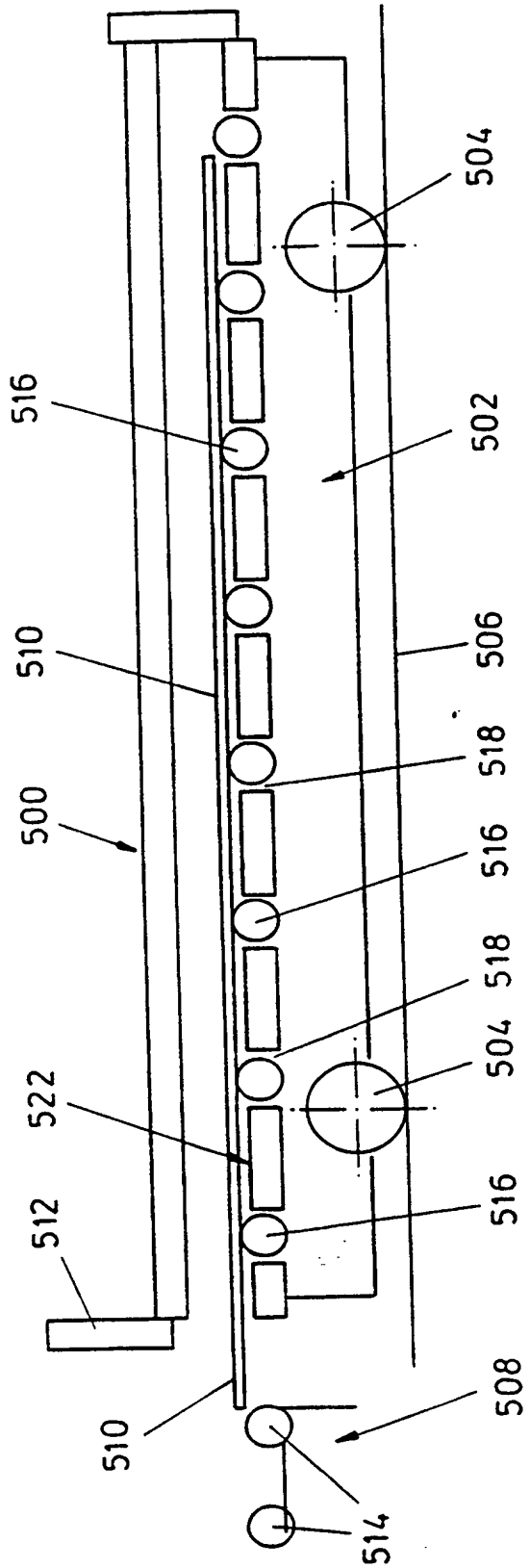


FIG. 14a

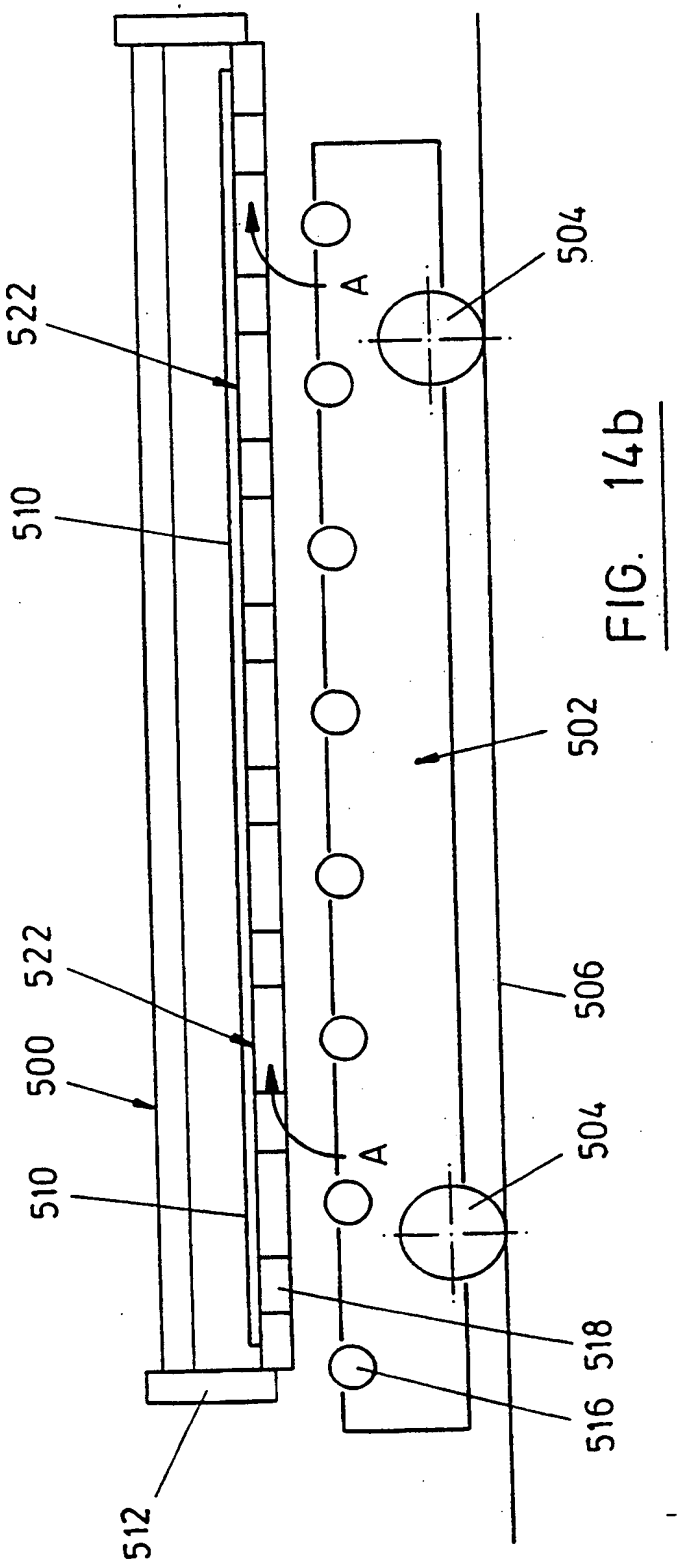


FIG. 14b

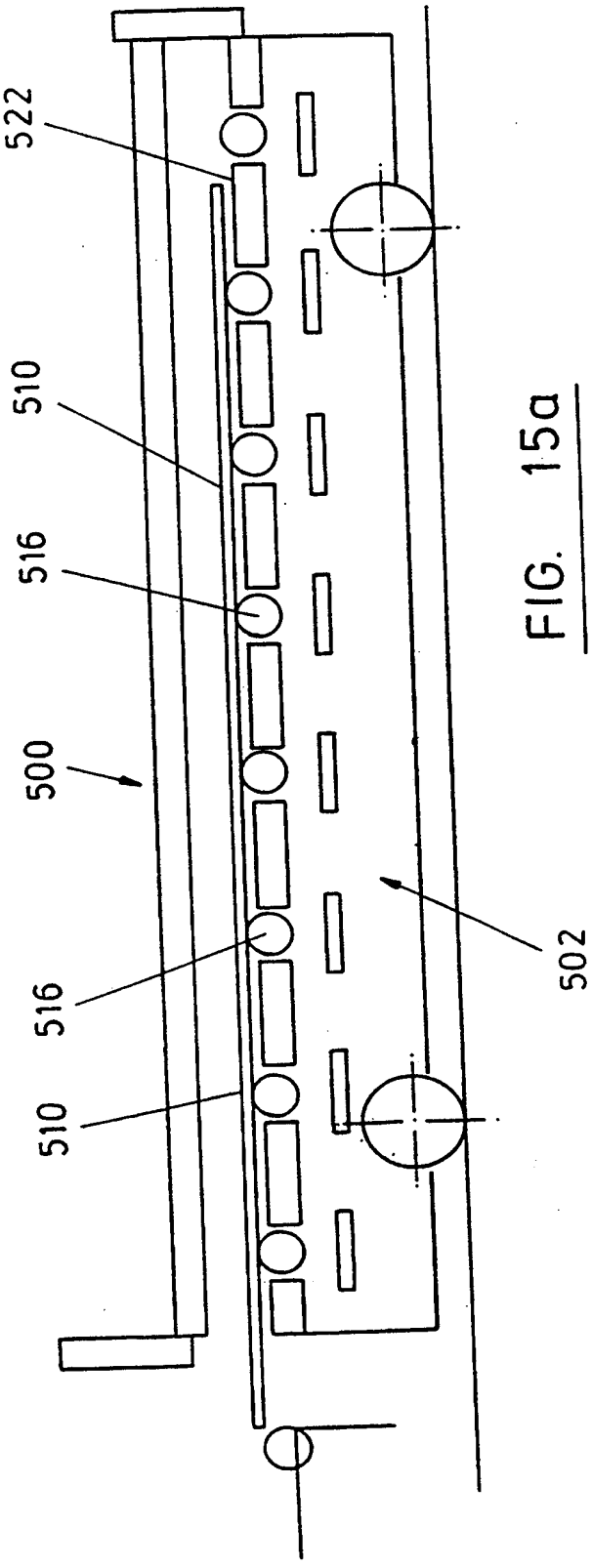


FIG. 15a

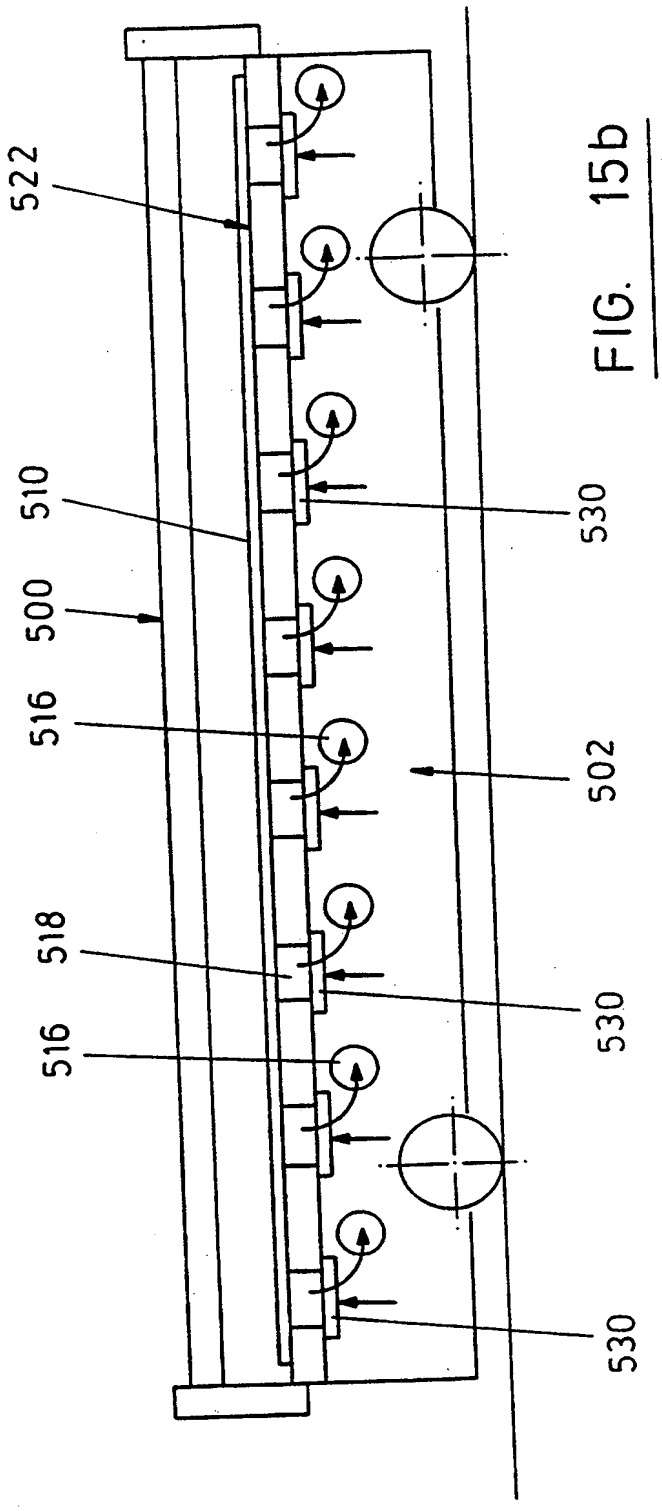


FIG. 15b

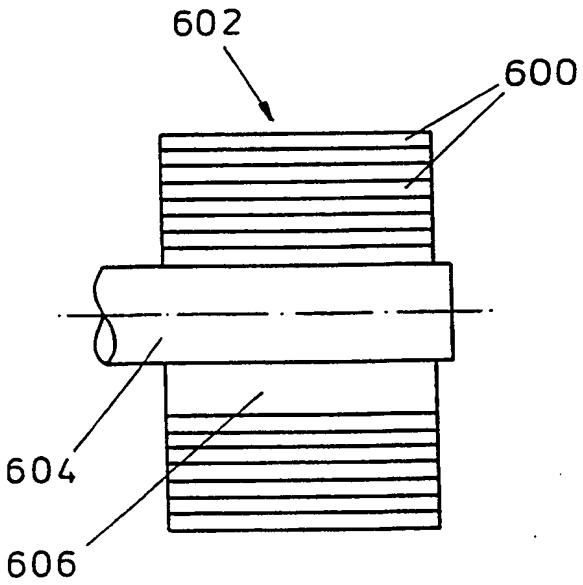


FIG. 16a

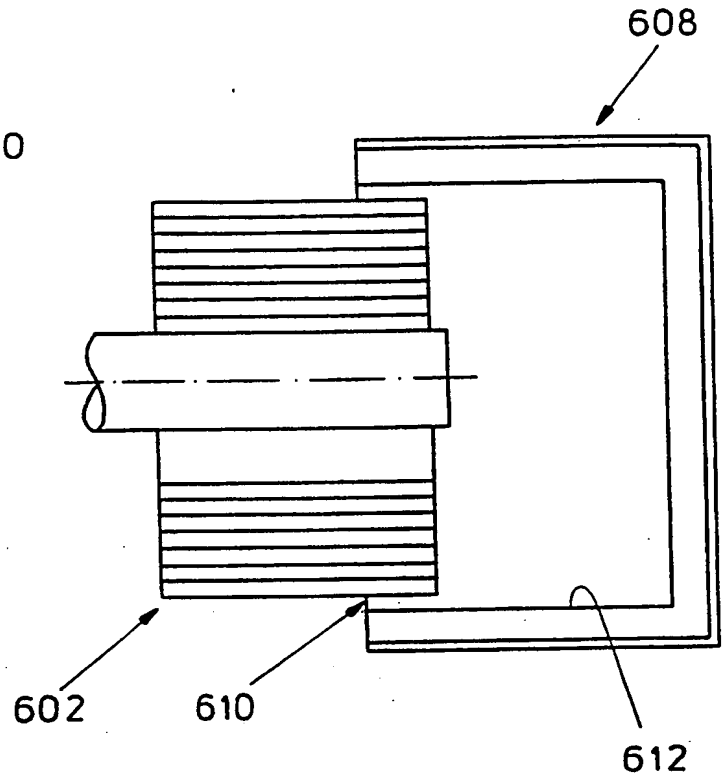


FIG. 16b

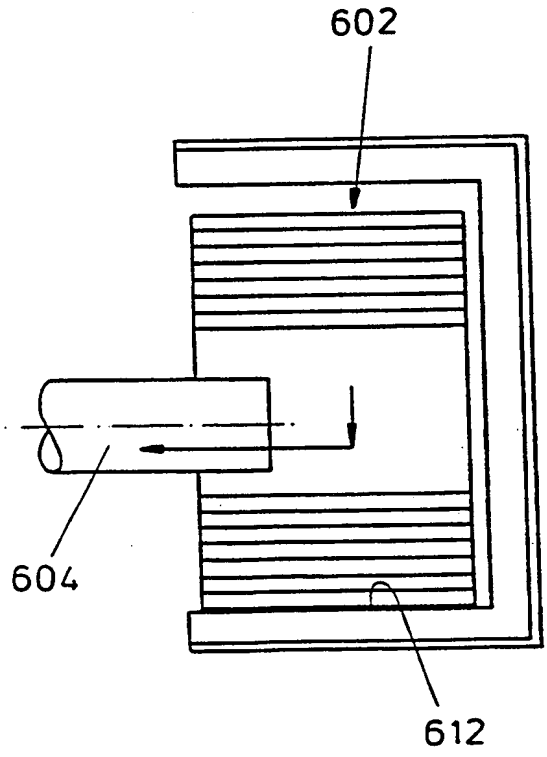


FIG. 16c

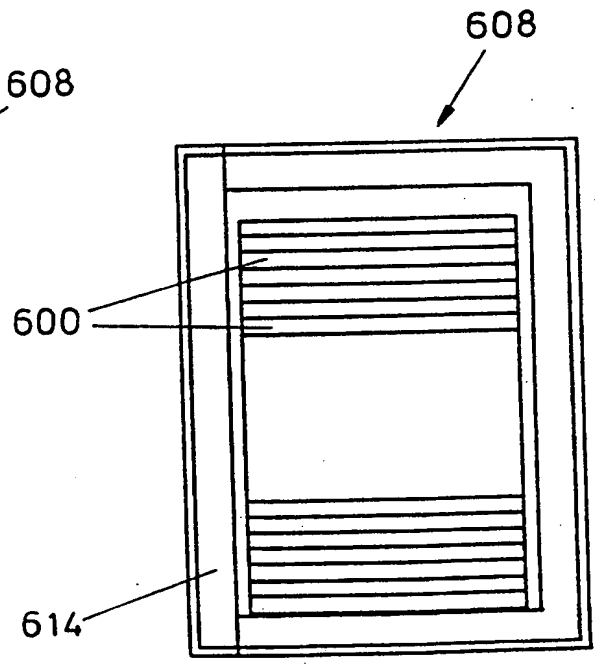


FIG. 16d

INTERNATIONAL SEARCH REPORT

Intern ial Application No
PCT/GB 98/02325

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 C21D9/00 F27D5/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 C21D F27D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	EP 0 330 293 A (ENCOMECH ENG SERVICES) 30 August 1989 see the whole document	1-5, 11-26 32-35
Y	DE 11 98 393 B (DEUTSCHE EDELSTAHLWERKE) 12 August 1965 see the whole document	32-35
A	FR 1 267 430 A (J.M. MOUTON) 22 November 1961	
A	US 4 192 646 A (BERG CHARLES A) 11 March 1980	
A	DE 40 07 852 C (AICHELIN) 29 May 1991	
A	DE 29 00 497 A (ARBED) 6 March 1980	

-/--

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
1 December 1998	11/12/1998

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Mollet, G

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

Intern ial Application No
PCT/GB 98/02325

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
A	US 2 033 822 A (J. FALLON) 10 March 1936	

INTERNATIONAL SEARCH REPORT

Information on patent family members

Intern ıal Application No
PCT/GB 98/02325

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 0330293 A	30-08-1989	EP 0516250 A	02-12-1992
		AT 137427 T	15-05-1996
		AT 133096 T	15-02-1996
		CA 1278443 A	02-01-1991
		CA 1295479 A	11-02-1992
		DE 3587545 D	30-09-1993
		DE 3587545 T	28-04-1994
		DE 3588079 D	29-02-1996
		DE 3588079 T	10-10-1996
		DE 3588105 D	05-06-1996
		DE 3588105 T	24-10-1996
		EP 0181740 A	21-05-1986
		JP 1911715 C	09-03-1995
		JP 6035033 B	11-05-1994
		JP 61159253 A	18-07-1986
		JP 1971361 C	27-09-1995
		JP 6122012 A	06-05-1994
		JP 7000203 B	11-01-1995
		JP 6122053 A	06-05-1994
		JP 6122054 A	06-05-1994
		US 5033926 A	23-07-1991
		US 4736608 A	12-04-1988
DE 1198393 B		NONE	
FR 1267430 A	22-11-1961	NONE	
US 4192646 A	11-03-1980	NONE	
DE 4007852 C	29-05-1991	NONE	
DE 2900497 A	06-03-1980	LU 80145 A	21-04-1980
		AT 555979 A	15-03-1985
		AU 531997 B	15-09-1983
		AU 5007279 A	28-02-1980
		BE 878275 A	17-12-1979
		CA 1149349 A	05-07-1983
		FR 2438227 A	30-04-1980
		GB 2032309 A,B	08-05-1980
		JP 55047316 A	03-04-1980
		NL 7906234 A	26-02-1980
		SE 437568 B	04-03-1985
		SE 7906822 A	23-02-1980
		US 4314790 A	09-02-1982
US 2033822 A	10-03-1936	NONE	